

Progress Report

December 2, 2015

Steam Enhanced Extraction at the Former Williams AFB,
ST012 Site

Mesa, AZ



1. Summary

This report covers the period of operations from Tuesday, November 24, 2015 through Monday, November 30, 2015. The following table provides a summary of the project operational status.

Table 1. Project Summary

	Value	Unit
Target Treatment Zone (TTZ) Soil Volume	410,000	cubic yards (cy)
Area	199,000	square feet (ft ²)
Upper Depth of Treatment	145	feet (ft) below ground surface (bgs)
Lower Depth of Treatment	245	ft bgs
Vapor Liquid Treatment Started	09/29/14	
Thermal Operations Started	09/29/14	
Last Process Data Update	11/30/15	
Last Temperature Data Update	11/30/15	
Estimated Total Days of Operation	422	days
Days of Operation	427	days
Days of Operation vs. Estimate	101	percent (%)
Estimated Total Energy Usage	11,343,000	kilowatt hours (kWh)
Total Energy Used	4,289,333	kWh
Used Electrical Energy vs. Estimate	38	%
Total Steam Injected	263.6	million pounds (lbs)
Projected Total Steam Injection	320	million lbs
Steam Injected Vs Projected	82	%
Total Mass Removed in Vapor Based on Photoionization Detector (PID) Readings	904,652	lbs
Total Mass Removed as NAPL	1,155,110	lbs
Average Daily NAPL Mass Removal Last Week	0	lbs/day
Total Vapor and Liquid Mass Removal (based on PID readings)	2,059,762	lbs
Average Power Usage Rate Last Week	107	kilowatts (kW)
Average Wellfield Vapor Extraction Rate Last Week	371	standard cubic feet per minute (scfm)
Average Condensate Production Rate Last Week	0.2	gallons per minute (gpm)
Average Water Extraction Rate Last Week	25	gpm
Total Water Extracted	65,832,441	gallons
Total Recovered Light Non-Aqueous Phase Liquid	175,816	gallons
Average Water Discharge Rate Last Week	40	gpm
Total Treated Water Discharge	86,913,000	gallons

Operational highlights from the past week include:

- On Tuesday, November 24, 2015 the City of Mesa (COM) contacted Amec Foster Wheeler (Amec FW) to report that one of the two pumps at a lift station downgradient from the ST012 outfall failed and the remaining pump was not able to keep up with flow in the line. The ST012 liquid extraction system was taken offline and steam injection reduced to a minimum on Tuesday evening for the time needed to replace the pump
- As the pump was not replaced by Thursday November 26, 2015, the Steam Enhanced Extraction (SEE) boilers were completely turned off for hydraulic control reasons. The steam injection and liquid extraction systems remained off through the end of this reporting period.
- The vapor extraction system remained operational during this operational period.
- The average liquid extraction rate from the formation was approximately 25 gpm for this operational period as the eductor system only was operational for 1.5 days during this period.
- The average steam injection rate in the Lower Saturated Zone (LSZ) was 6,700 lbs/hr (or 13.4 gpm).
- The average steam injection rate in the Upper Water Bearing Zone (UWBZ) was 2,400 lbs/hr (or 4.8 gpm).
- The average steam injection rate in the Cobble Zone (CZ) was 3,200 lbs/hr (or 6.4 gpm).
- The average steam injection rate as water for all zones was 24.6 gpm.
- The net extraction from the formation was 0.4 gpm (approximately the same water volume injected as steam was extracted as water).
- Collected process, wellfield and laboratory data per the sampling schedule, except from parts of the system affected by the shutdown.
- Conducted regular maintenance on the treatment system.
- The following MPE wells were identified as requiring maintenance during this operational period:
 - UWBZ-2*
 - UWBZ-27
 - LSZ-5*
 - CZ-7

**Temperatures at these MPE wells are at boiling – well maintenance will be postponed until temperatures are below boiling due to health and safety concerns.*

2. Vapor Extraction

Figure 1 below shows the vapor extraction rate from the site. Note that the estimated steam extraction rate is a calculated value based on the water generated at the moisture separators after cooling the vapors from the wellfield. Based on energy balance analysis, additional steam is likely being pulled into and condensing in the liquid extraction system. This steam extraction is not measureable and not accounted for in Figure 1. Additionally the wellfield flow is calculated as the difference between the air stripper flows and thermal accelerator influent, and is therefore only an estimate.

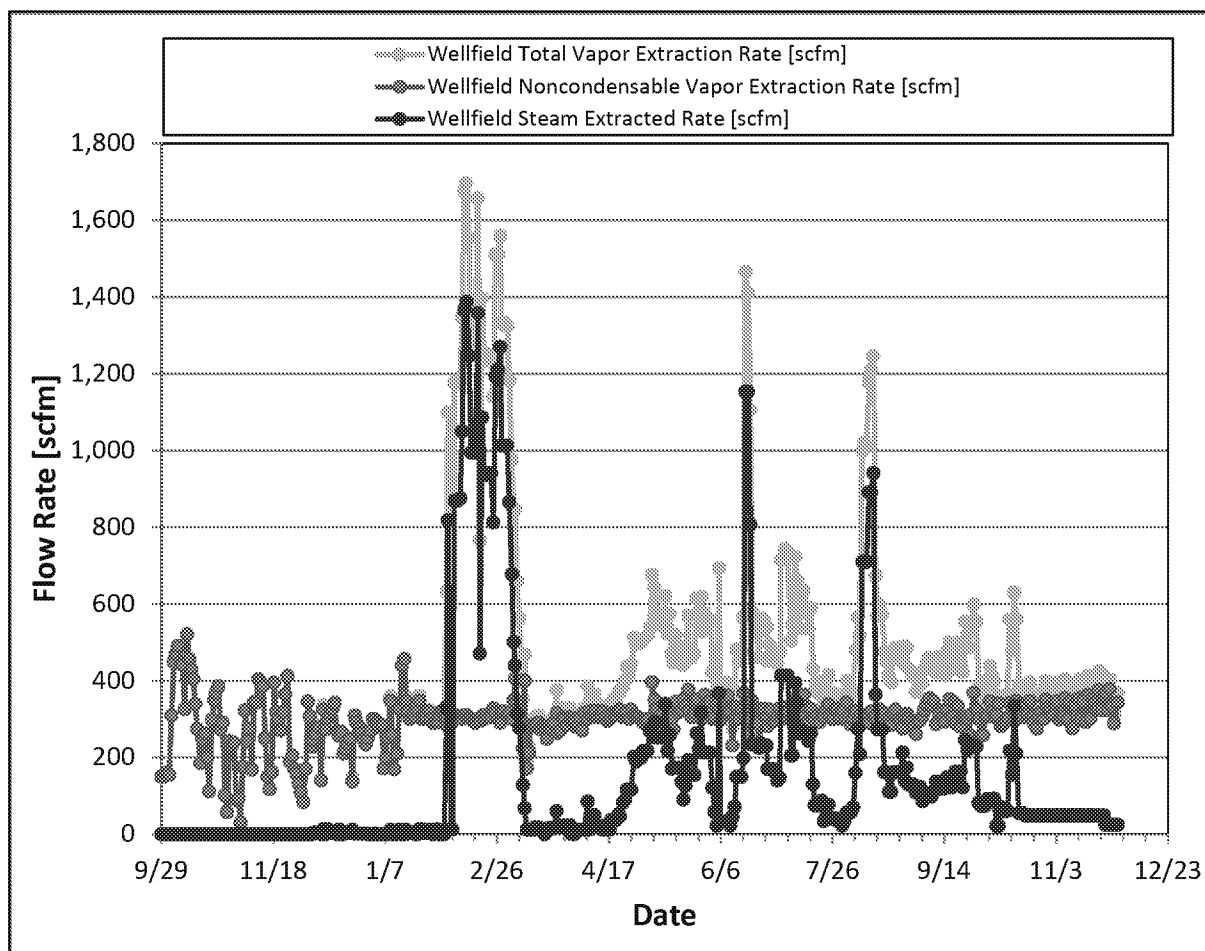


Figure 1. Vapor Extraction Rate

Note: Well SVE01M was tied into the SEE extraction system on June 5, 2015. Wells SVE10M and SVE14M were tied into the SEE extraction system on September 23, 2015.

3. PID Measurements

The following figure depicts the PID concentrations from the wellfield effluent to the effluent of the thermal accelerators collected since the start of operations. Note that PID readings of 0.0 parts per million by volume (ppmV) are shown in the figures as 0.01 ppmV due to the logarithmic scale that does not allow display of 0-values. Accelerator influent readings are interpolated for days where no data is collected, since the value is used in the mass removal calculation.

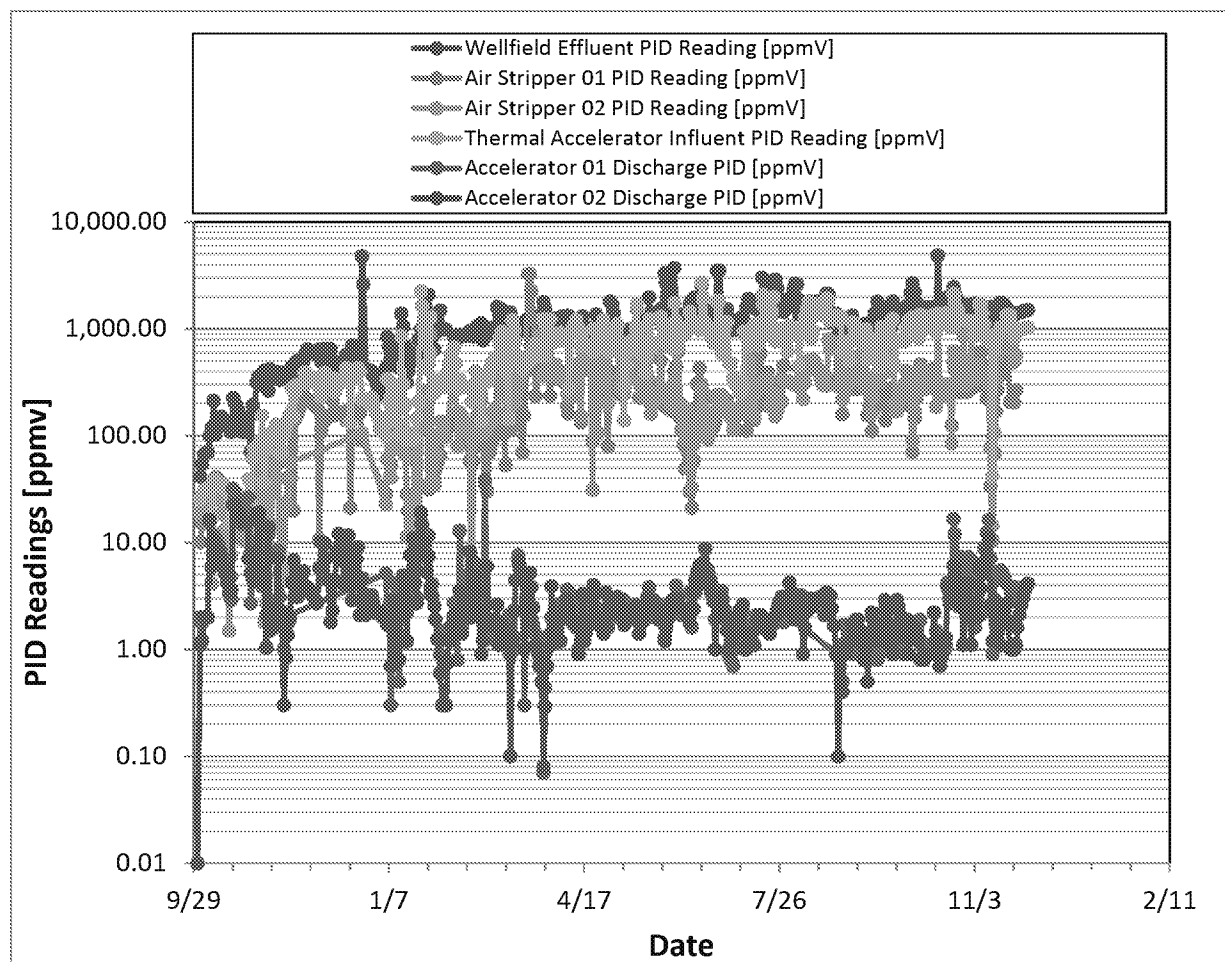


Figure 2. PID Readings

4. Mass Removal

The mass removal is calculated based on the PID and laboratory data collected at the thermal accelerator influent and the LNAPL recovered. The figure also depicts the mass removed based on PID and laboratory data.

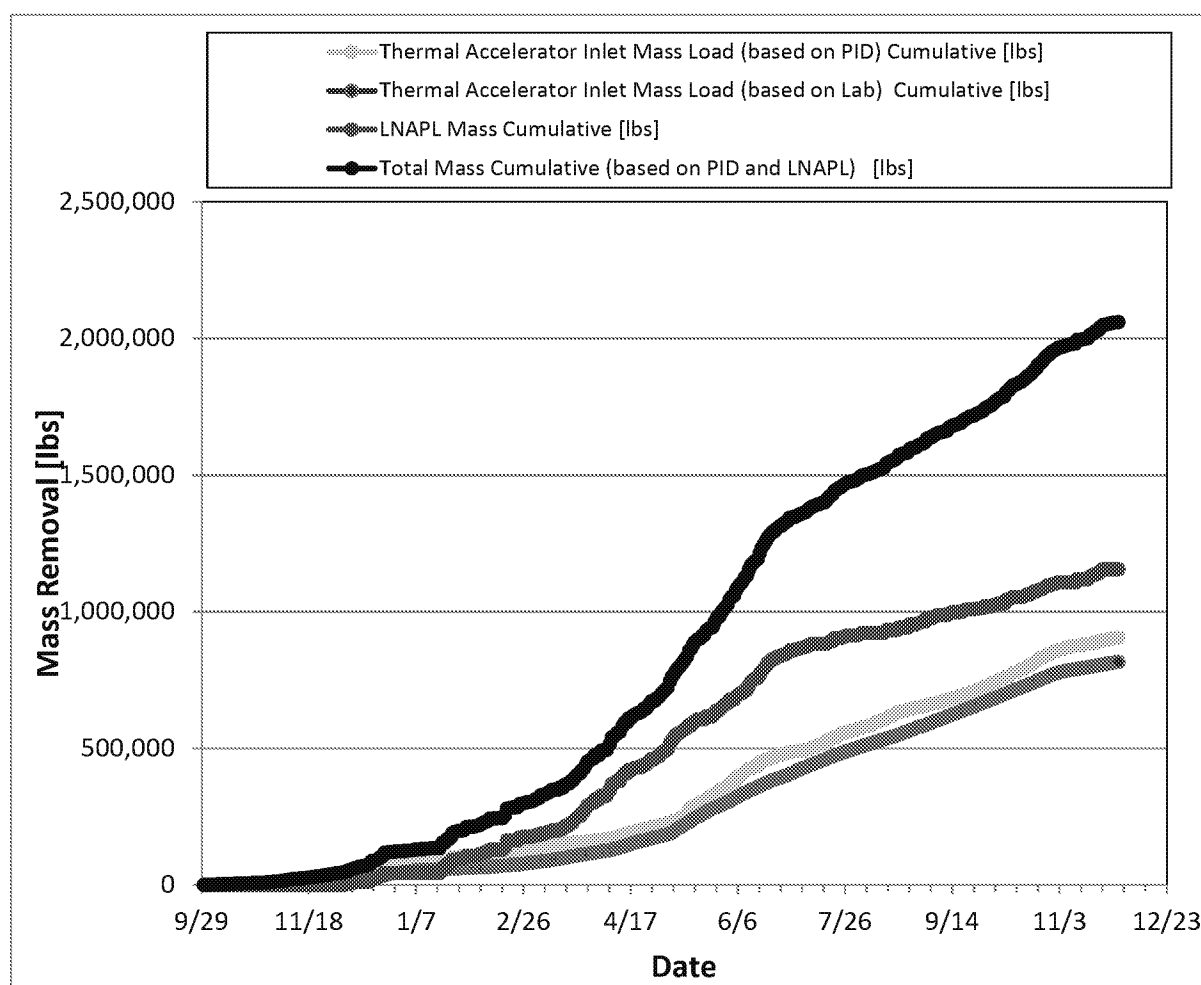


Figure 3. Mass Removal

Note: A NAPL density of 6.57 lbs/gallons was used to convert the NAPL volume to pounds. A molecular weight of 106,168 g/mol (corresponding to xylene) was used to convert PID readings to concentrations.

5. Daily Mass Removed

Figure 4 outlines the daily mass removed as vapor and LNAPL. The total daily mass removed is the combination of vapor and LNAPL. The liquid mass removal is captured in the vapor phase due to the volatilization of liquid contaminants in the air strippers.

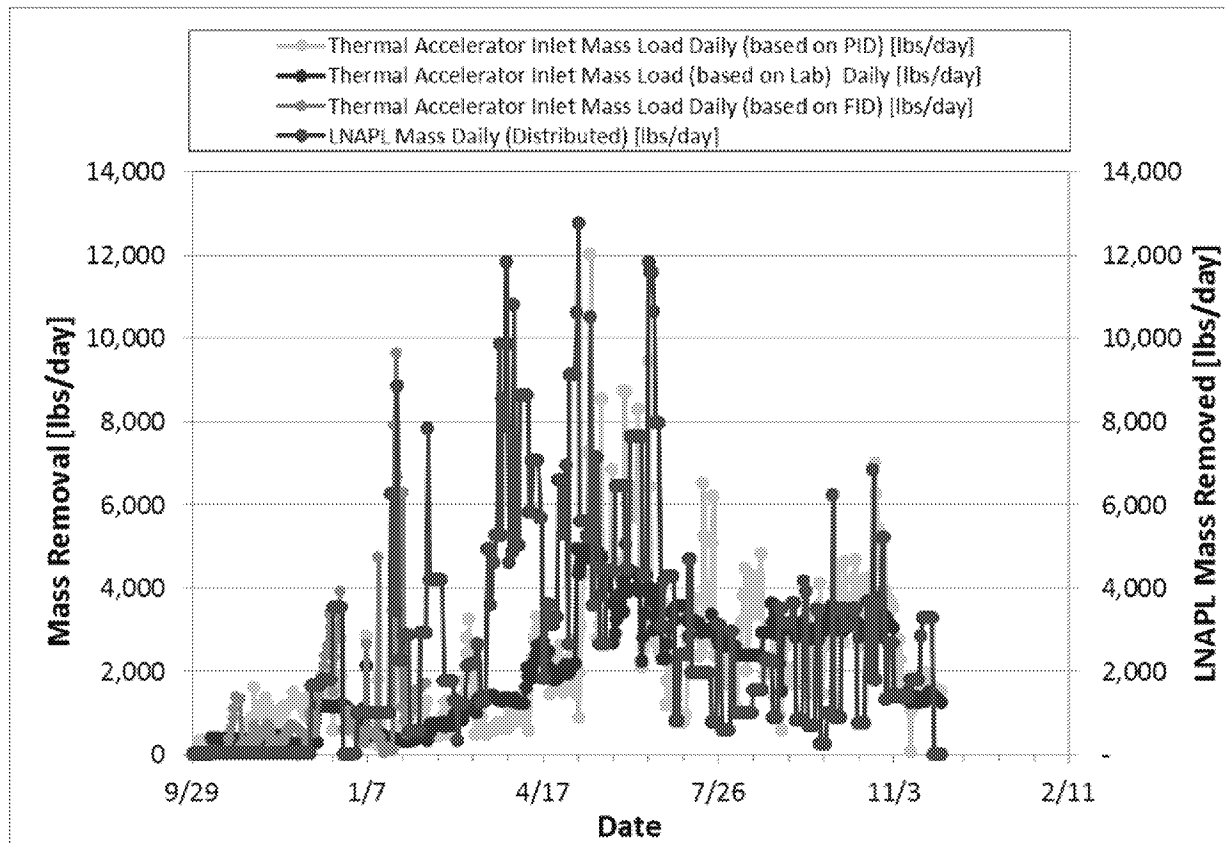


Figure 4. Daily Mass Removed

Note: Laboratory data are not collected daily. The “Thermal Accelerator Inlet Mass Load (based on lab)” is an average daily rate of actual lab data collected. The report has been updated based on lab data received for samples collected through November 3, 2015.

Note that accumulated LNAPL is pumped through the NAPL conditioning system in a batch style process. The LNAPL daily mass removal rate has been calculated by calculating an average daily rate based on the total gallons processed each batch over the number of days between batches.

6. Power Usage

The cumulative power usage is shown below. All electricity used at the site is utilized to run the process system and steam generators.

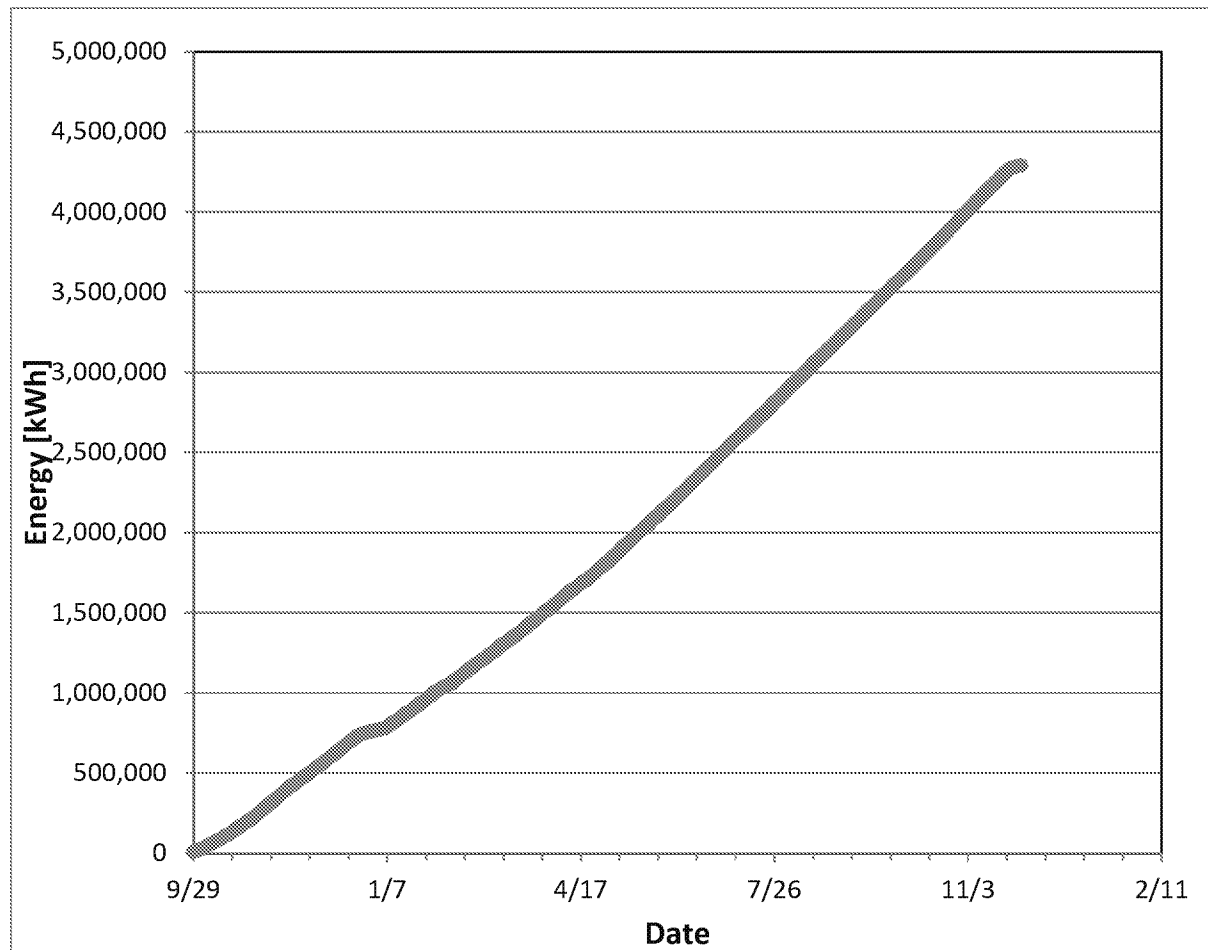


Figure 5. Cumulative Power Usage

7. Average Temperature

A detailed review of thermocouple sensor depths and temperatures over time was performed week ending November 13, 2015. Results of the review and updates are detailed in Table 2 below and shown in Figure 6 below.

Table 2. Temperature Monitoring Sensor History

Temperature Monitoring Point	Temperature Monitoring Sensor History
TMP01	Well compromised 6/9/2015, select sensors back online 7/15/2015. Well not extended down in the Lower Permeable Zone (LPZ) and LSZ.
TMP04	Well compromised 6/21/2015. Not included in LPZ and LSZ since 6/21/2015.
TMP05	Well compromised 5/6/2015, select sensors back online 7/15/2015. Sensors deeper than 160 ft have not been online since 5/6/2015 and therefore are not included in UWBZ, LPZ and LSZ.
TMP06	Well compromised 3/27/2015, select sensors back online 7/14/2015. On 9/10/2015 all sensors went offline and have been excluded from LPZ and LSZ averages.
TMP07	Well compromised 3/27/2015, select sensors back online 7/14/2015.
TMP08	Well partly compromised 9/11/2015 from 210 ft and down. The 215 and 235 ft sensors are still operating.
TMP09	Well compromised 2/9/2015 before CZ was turned on and UWBZ was up to temperature. The CZ and UWBZ temperatures have been excluded. LSZ temperatures have not been updated since 2/9/2015 (taken out of LSZ average).
TMP12	Sensors from 150 to 170 ft bgs only at ~50C. Brings down the average in CZ and UWBZ.
TMP13	Well compromised 3/27/2015, select sensors back online 4/30/2015. Since 7/1/2015 no sensor deeper than 225 ft has been operational.
TMP15	Well compromised 8/15/2015. 8/15/2015 temperatures assumed from this day.
TMP17	Well compromised 3/27/2015, select sensors back online 6/12/2015 but not reporting properly, total failure 7/16/2015. Depths lower than 235 not included in average since well was not at temperature when sensors failed. 7/16/2015 temperatures applied to average since well failed.

The average soil temperatures as degrees Celsius ($^{\circ}\text{C}$) and degrees Fahrenheit ($^{\circ}\text{F}$) are shown in the figure below by treatment zone (i.e., LSZ, UWBZ and CZ).

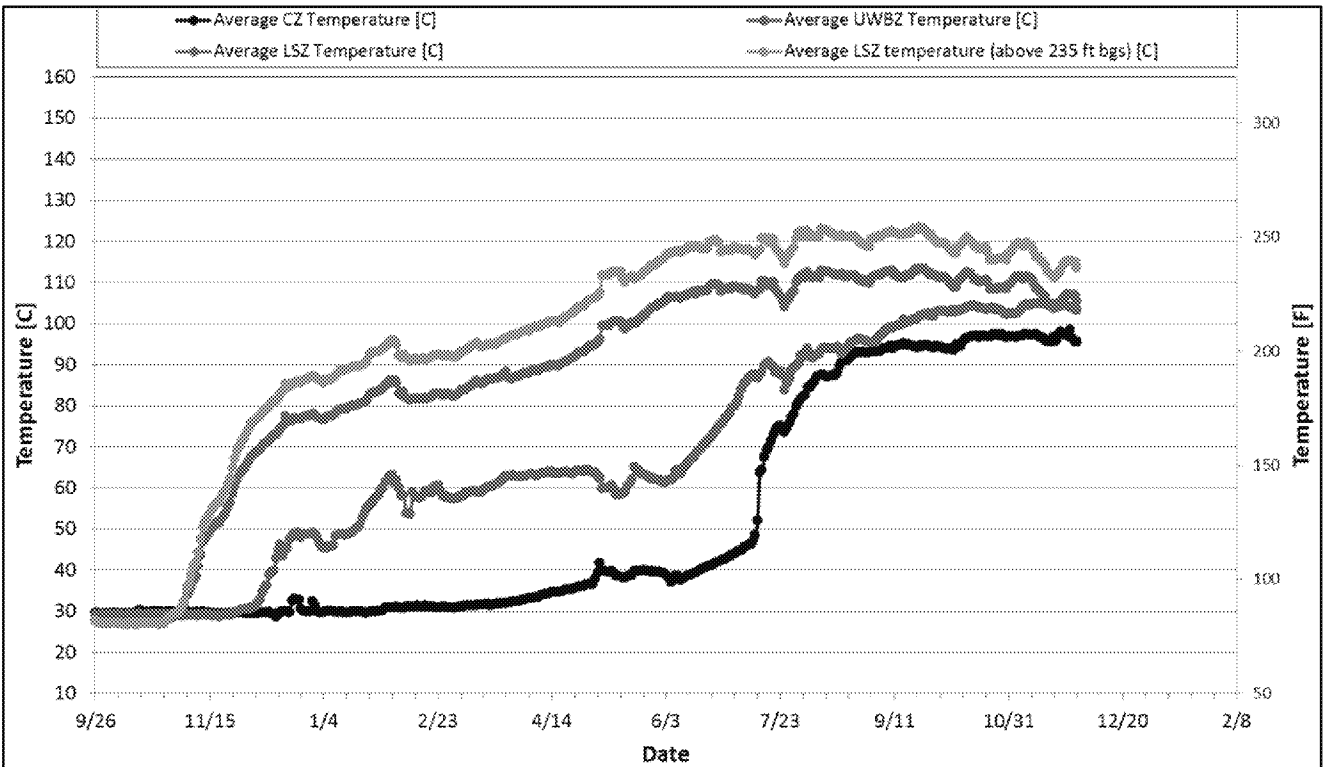


Figure 6. Average Soil Temperatures

Table 3 below provides a breakdown of the maximum average temperatures achieved at individual temperature monitoring points throughout SEE operations. The table below breaks down the average temperatures achieved across the CZ, UWBZ, Lower Permeability Zone (LPZ) and the LSZ. The LSZ is further broken down into the average for all LSZ sensors and those LSZ sensors above 235 ft bgs.

Table 3. Temperature Monitoring Point Maximum Depth-Averaged Temperature

Temperature Monitoring Point	Temperature Monitoring Point Maximum Depth-Averaged Temperature ¹ (°C) During SEE Operations by Zone				
	CZ	UWBZ	LPZ	LSZ	LSZ (depths above 235 ft bgs)
TMP01	114.6	130.5	N/A	N/A	N/A
TMP03	N/A	N/A	137.5	110.8	118.2
TMP04	N/A	N/A	103.8	118.8	127.1
TMP05	109.3	N/A	N/A	N/A	N/A
TMP06	N/A	N/A	137.4	135.0	135.9
TMP07	N/A	N/A	134.6	137.2	140.2
TMP08	N/A	N/A	136.6	131.3	135.4
TMP09	N/A	N/A	132.5	134.1	139.3
TMP11	N/A	N/A	107.5	119.1	131.7
TMP12	75.7	90.3	121.8	121.4	131.3
TMP13	102.1	119.8	130.6	140.3	142.7
TMP14	N/A	N/A	133.6	124.3	136.3
TMP15	113.1	123.3	128.7	126.5	135.6
TMP16	N/A	N/A	126.7	120.4	131.0
TMP17	N/A	N/A	145.7	143.9	143.9
Maximum depth-averaged by zone²	103.0	116.0	129.0	127.9	134.5

If N/A, Temperature Monitoring Point has no sensors in that zone

¹ Temperature of the thermocouples across each depth zone are averaged for each TMP and each available time interval and then the maximum value of those averages throughout operations is listed in the table.

² Average of maximum depth-averages listed above for all TMPs in each zone.

8. Vertical and Horizontal Temperature Profiles

The following Figures 7 and 8 show the temperature in °C versus depth profiles for each of the 17 individual temperature monitoring points. Please see Table 2 for an updated temperature monitoring sensor status.

Temperature highlights for the past week include:

- Generally all locations in the CZ, UWBZ and LSZ have seen a decrease in temperature due to the steam being shut off.
- Perimeter wells TMP 02 and TMP 10 have both remained relatively stable over the last week.
- TMP 03 has seen a decrease of approximately 20°C. The current high temp is 71°C at 225 ft bgs.
- TMP 07 has remained stable over the last week.
- TMP 08 has seen a general decrease of approximately 5°C since last week.

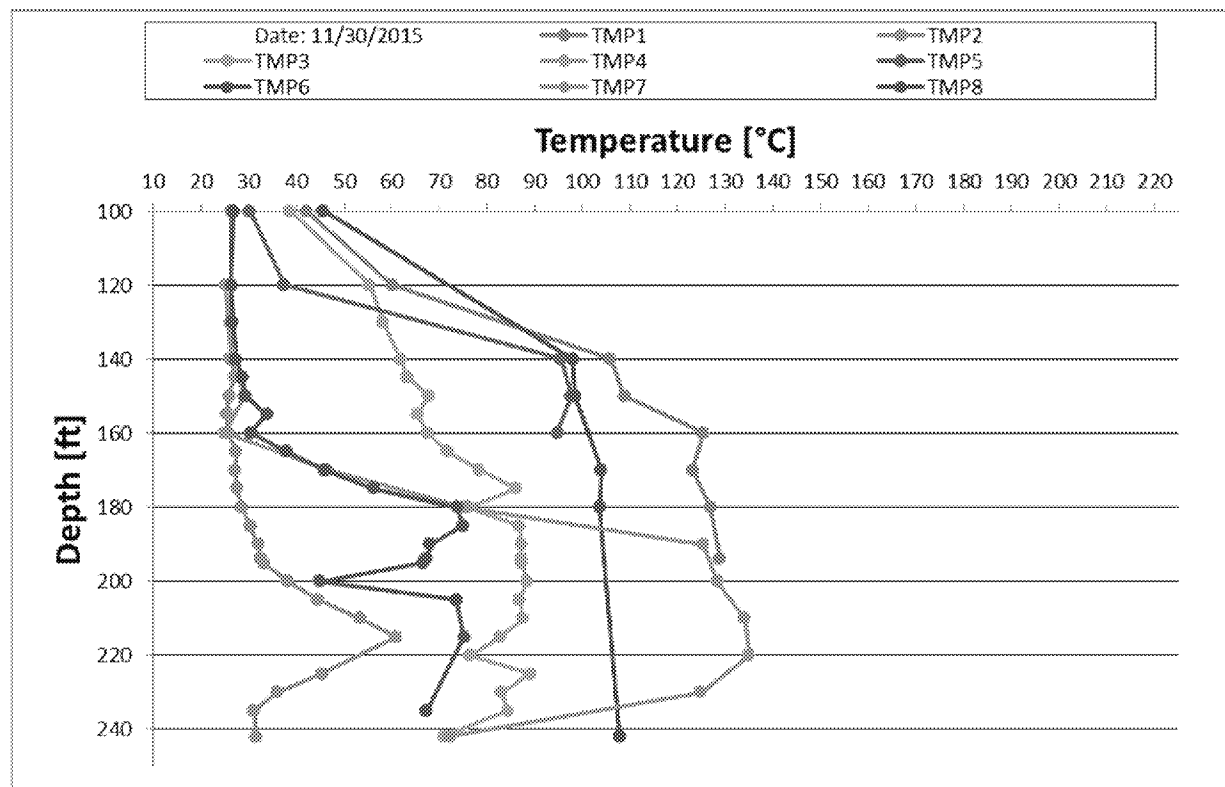


Figure 7. Vertical Temperature Profiles (TMP01 through TMP08)

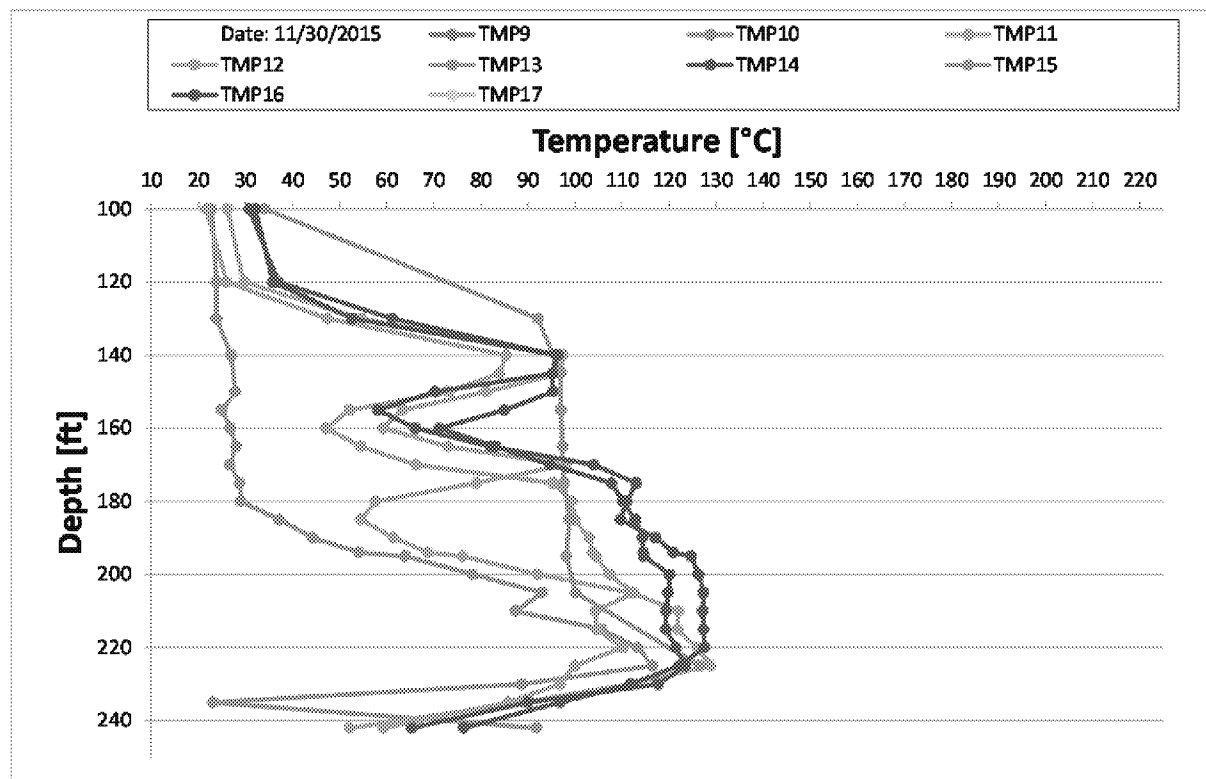


Figure 8. Vertical Temperature Profiles (TMP09 through TMP17)

Figures 9-12 show the horizontal temperature distribution across the site in four depth intervals.

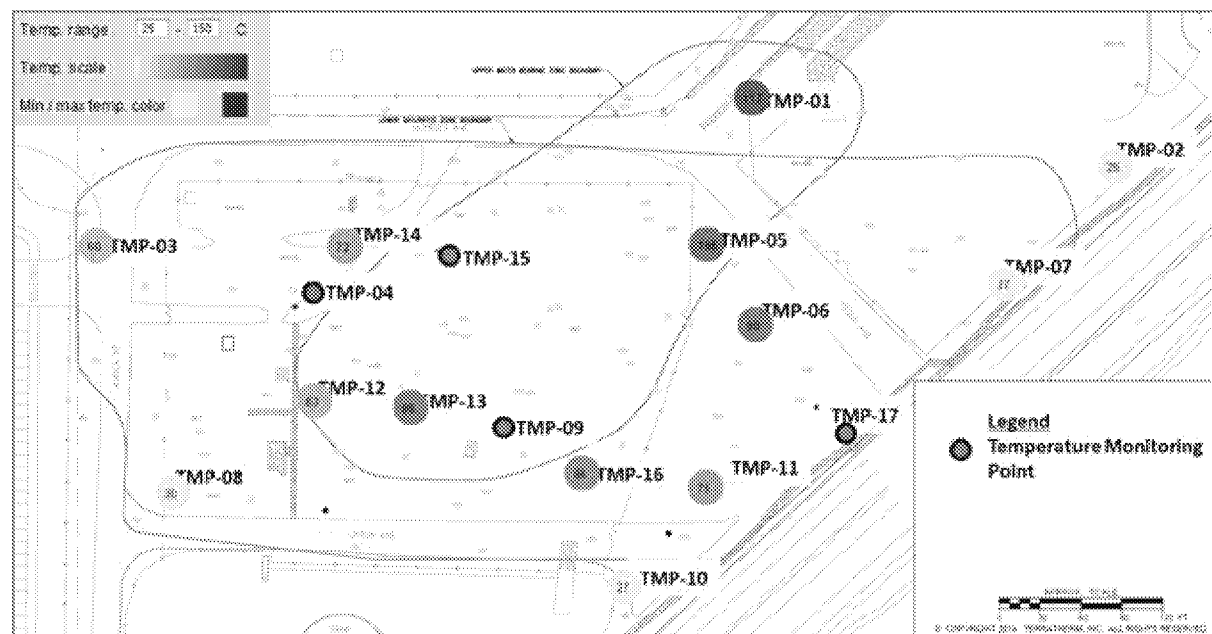


Figure 9. Horizontal Temperature Distribution across the CZ (145-160 ft bgs) (temperatures shown in °C)

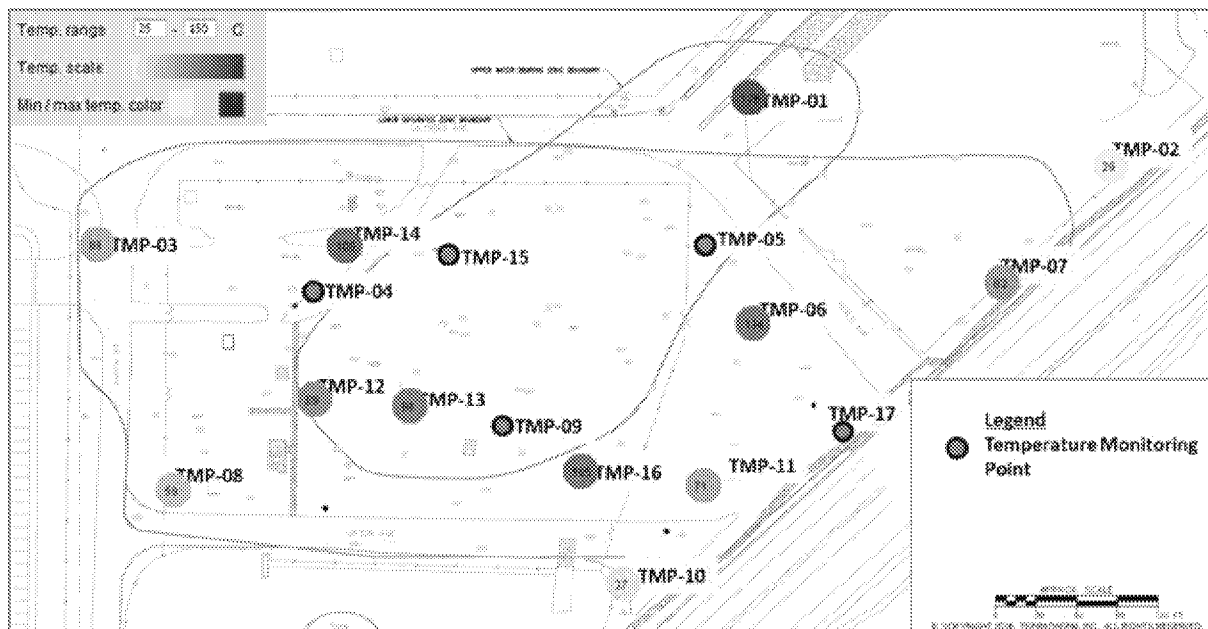


Figure 10. Horizontal Temperature Distribution across the UWBZ (161-195 ft bgs) (temperatures shown in °C)

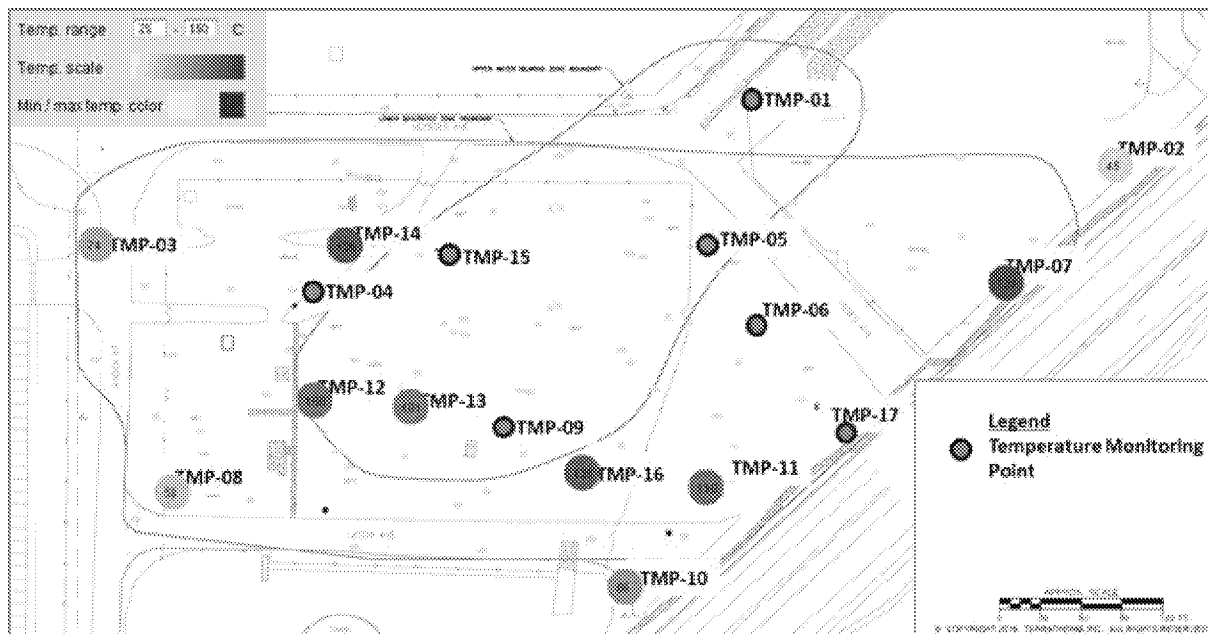


Figure 11. Horizontal Temperature Distribution across the Lower Permeable Zone (196-210 ft bgs) (temperatures shown in °C)

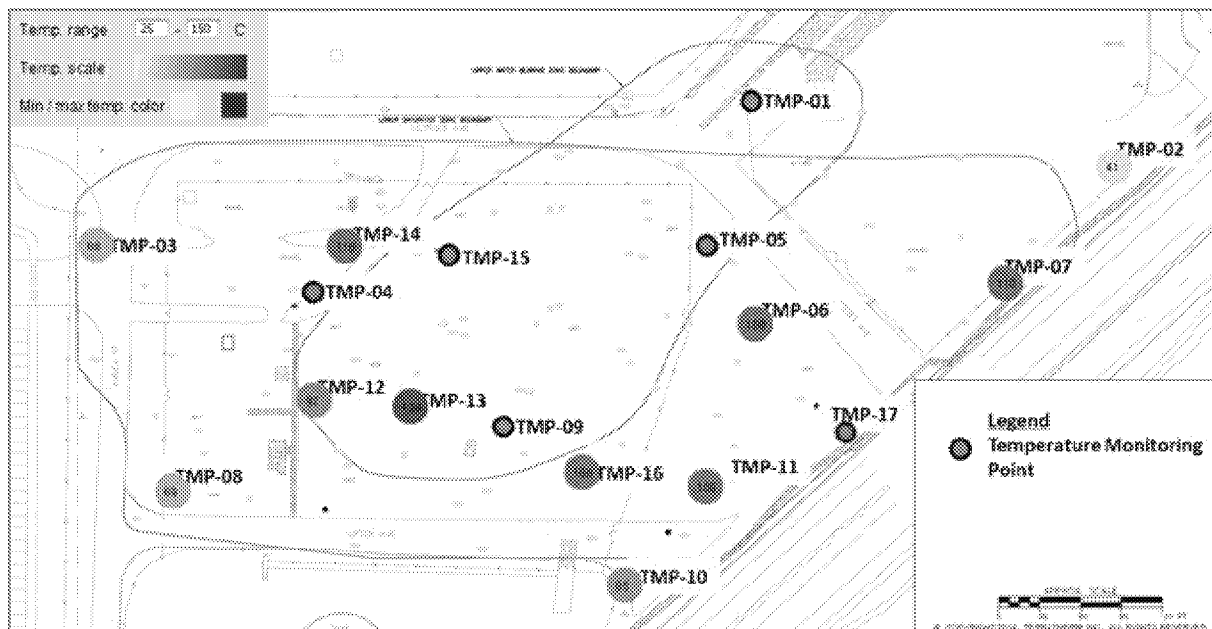


Figure 12. Horizontal Temperature Distribution across the LSZ (211-245 ft bgs) (temperatures shown in °C)

Figure 13 below shows the observed temperatures by depth at selected LSZ extraction wells.

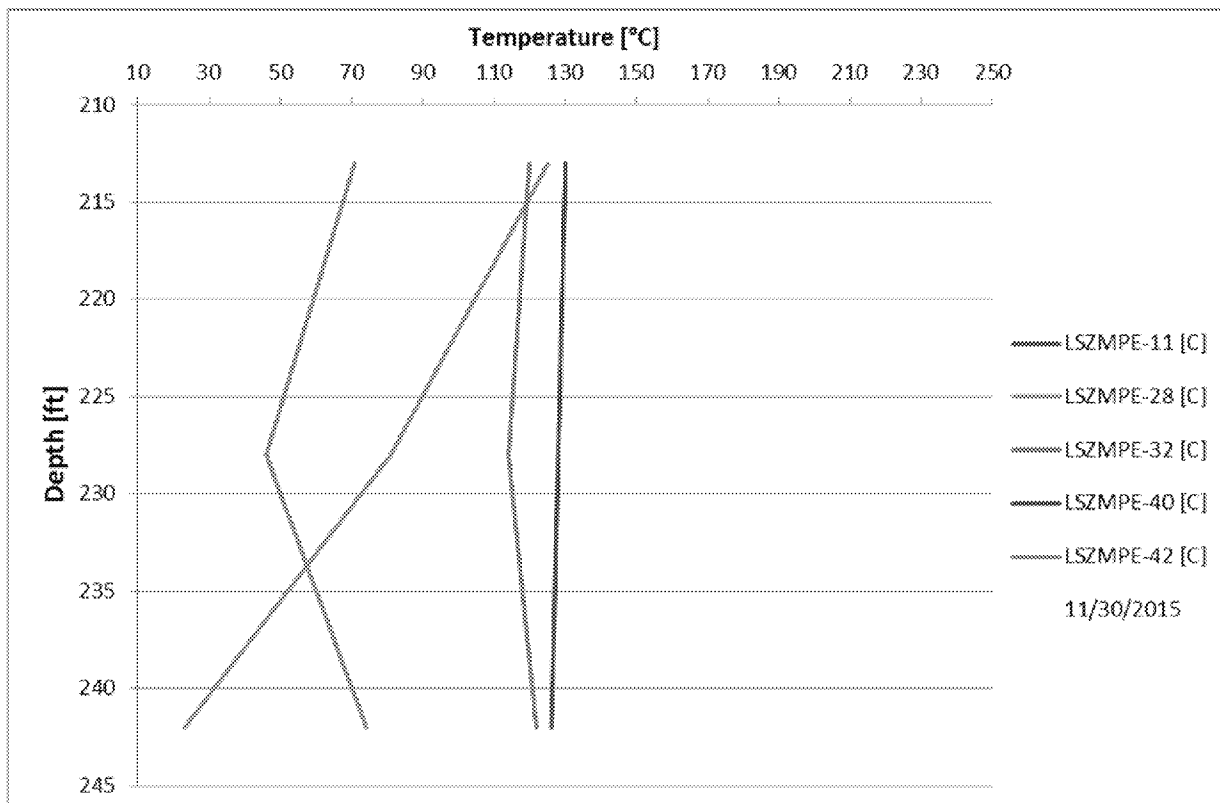


Figure 13. Temperatures by Depth at Selected LSZ Extraction Wells (211-245 ft bgs) (temperatures shown in °C)

9. Cumulative Steam Injection

Steam injection was initiated Thursday, October 16, 2014. Figure 14 below shows the cumulative steam injection for each of the three injection zones.

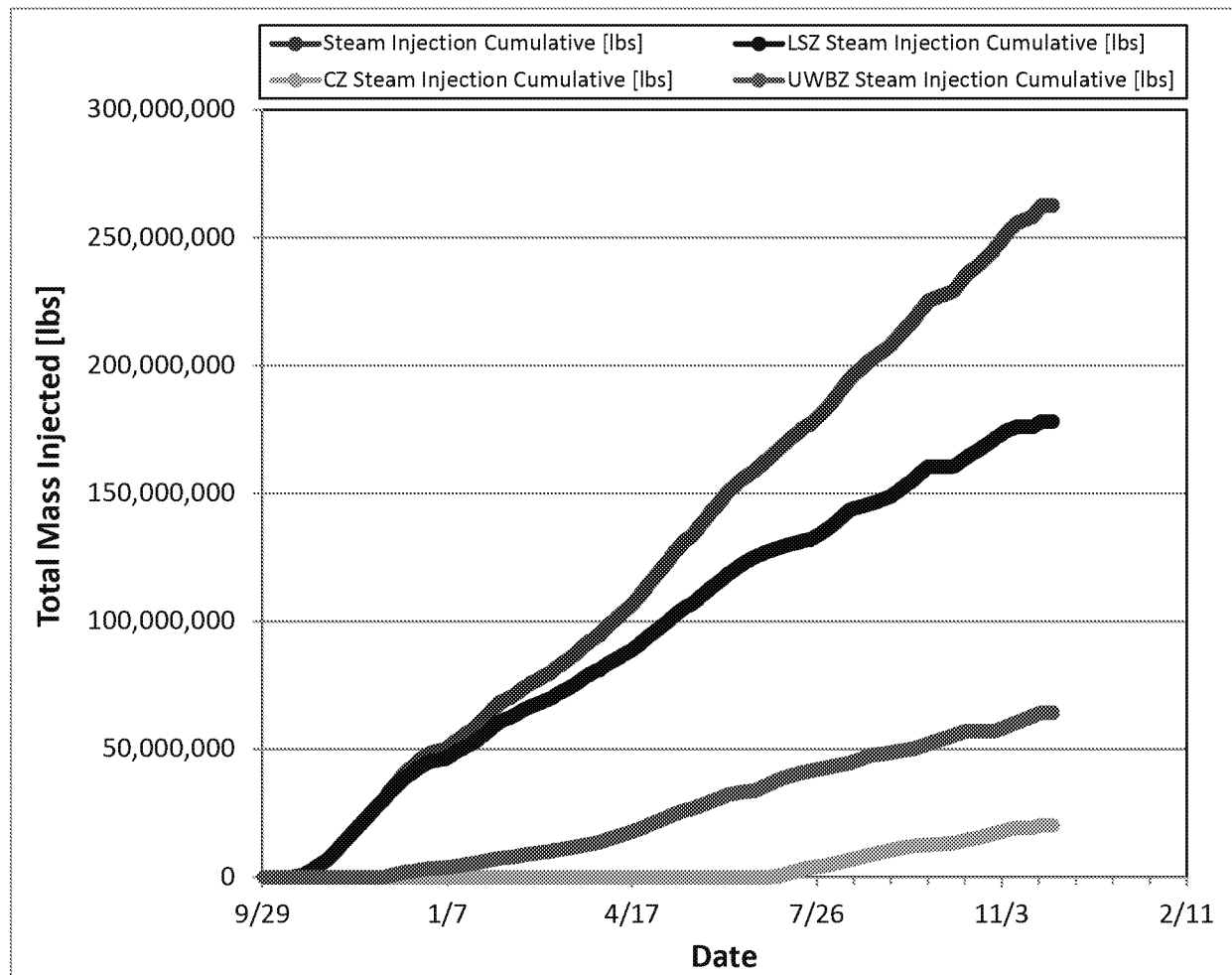


Figure 14. Cumulative Steam Injection for Each of the Three Injection Zones

10. Steam Injection Rates

The figure below shows the steam injection rates for each of the three injection zones.

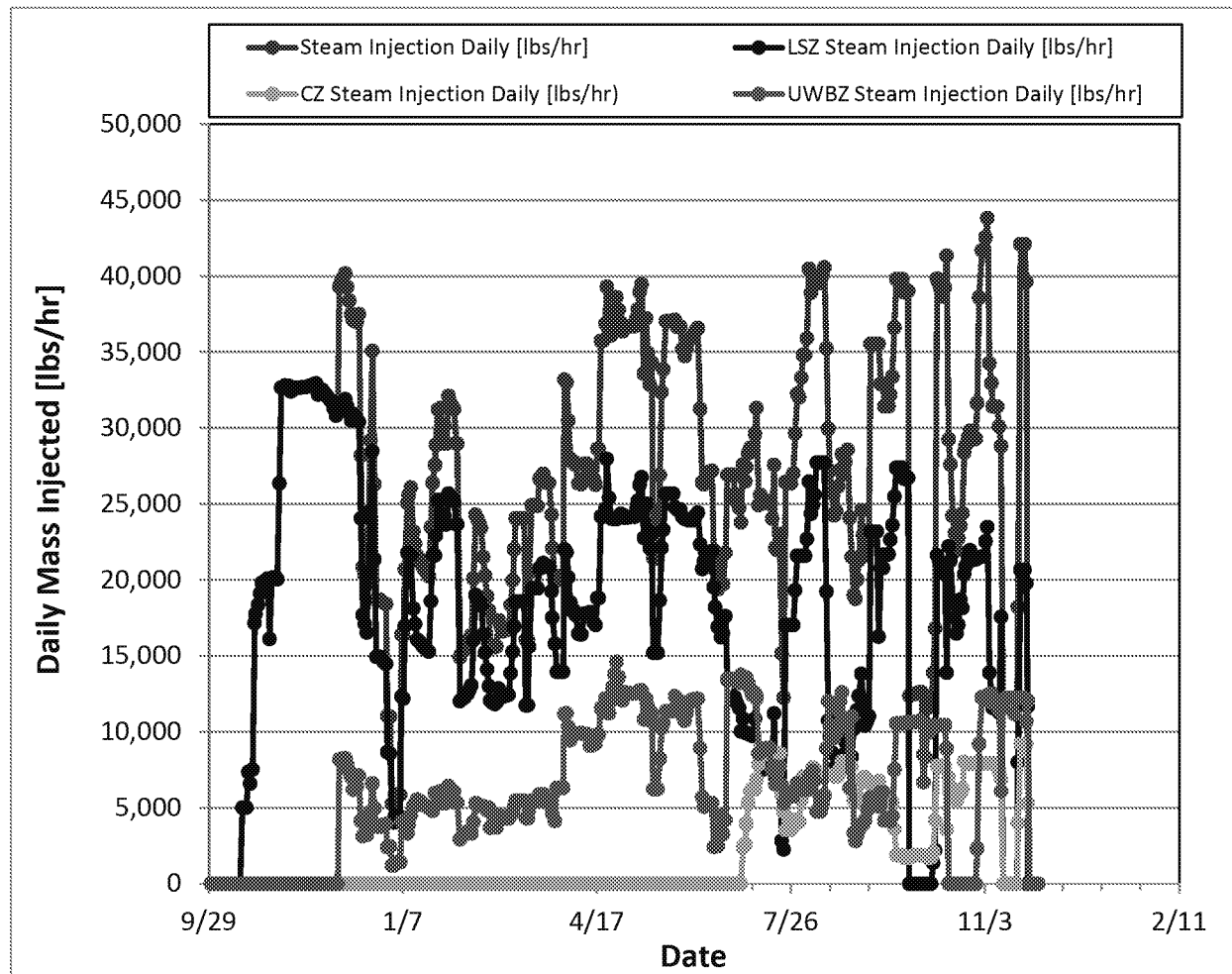


Figure 15. Steam Injection Rate for Each of the Three Injection Zones

11. Cumulative Water Extraction by Zone

The cumulative water extraction for each of the three treatment zones is shown below. The cumulative water extraction is calculated based on flow meters installed at each of the 57 extraction wells (accuracy should be considered +/- 20%). The figure below shows the net liquid extracted from the subsurface at the site and does not include the fraction of water that is recirculated to the eductor wells and used as motive water.

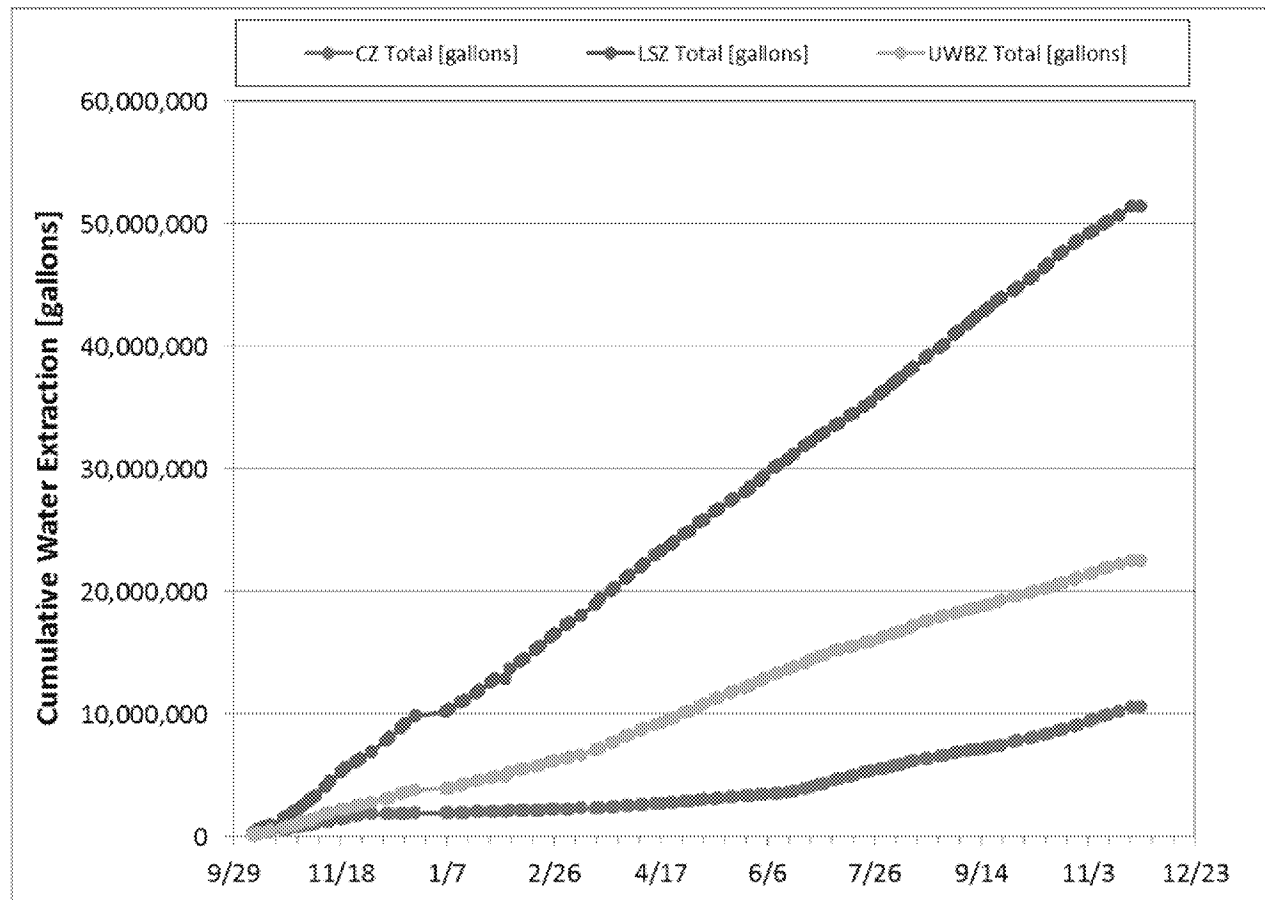


Figure 16. Cumulative Water Extraction for Each of the Three Treatment Zones

12. Water Extraction Rates by Zone

The figure below shows the water extraction rates for each of the three treatment zones.

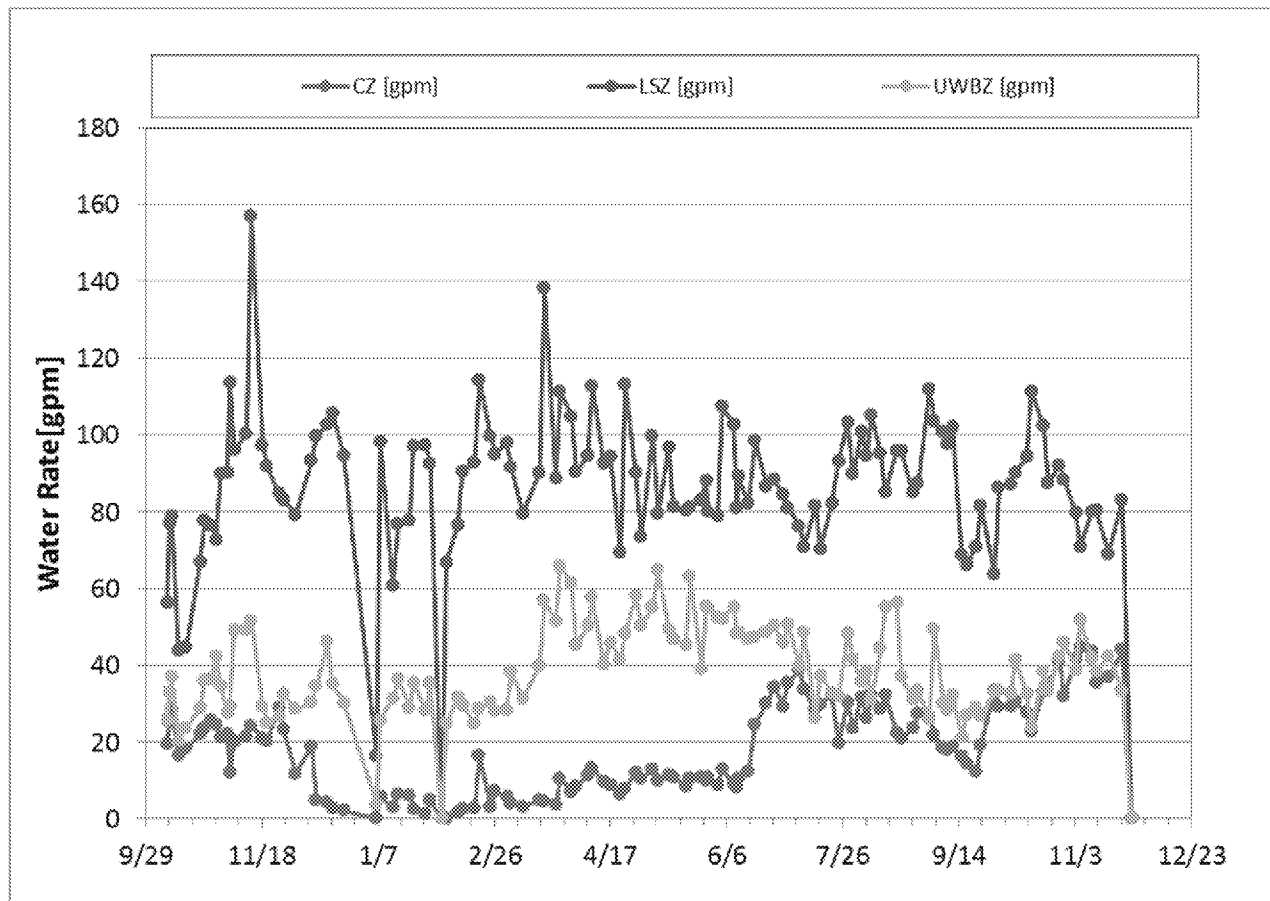


Figure 17. Water Extraction Rates for Each of the Three Treatment Zones

13. Cumulative Water Balance

The cumulative water balance for the site is shown below. The chart shows the net liquid extracted from the subsurface at the site and does not include the fraction of water that is recirculated to the eductor wells and used as motive water.

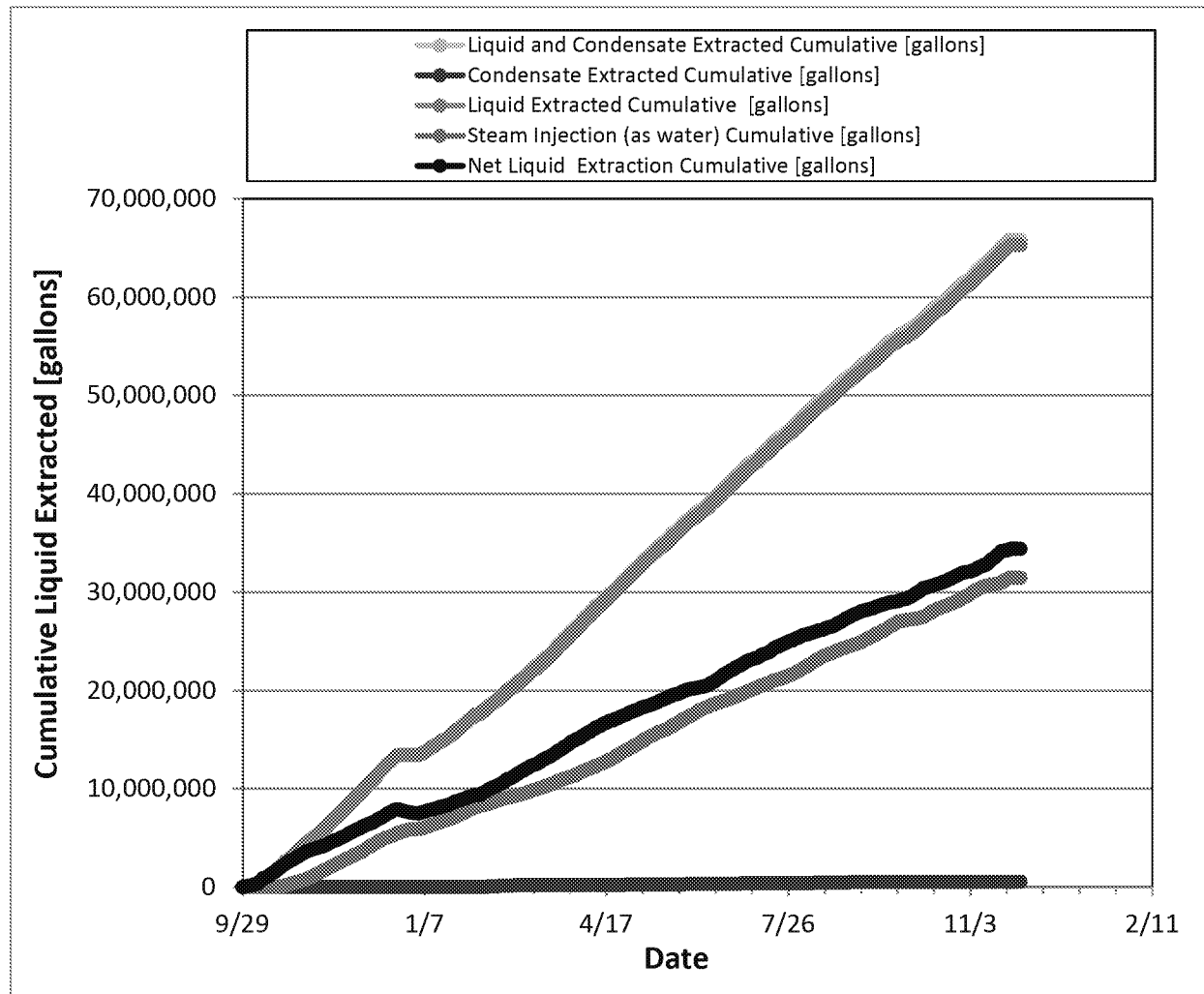


Figure 18. Cumulative Water Balance

14. Water Balance Rate

The total system water extraction rates are shown in the figure below.

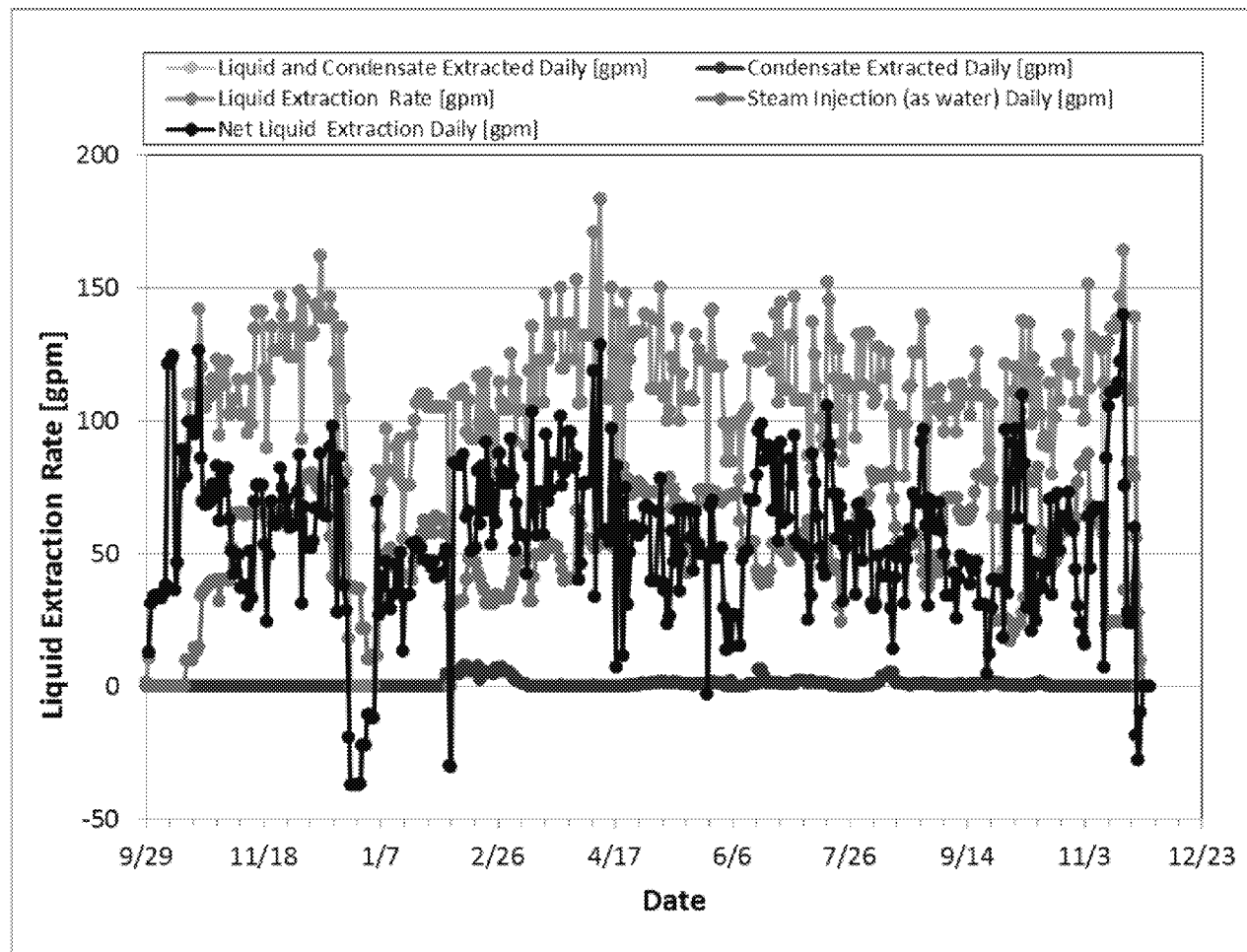


Figure 19. Water Balance Rates

15. Cumulative Energy Balance

The cumulative energy balance for the site is shown below. The energy balance has been updated to include calculated heat losses that are a combination of heat lost below the TTZ, above the TTZ and outside the TTZ. The heat losses were calculated according to the following approach:

- Based on the original SEE model, cumulative modeled heat losses were calculated for each operational phase (i.e., heat up, pressure cycling);
- The heat losses were compared to the cumulative energy added as steam for each operational phase;
- The percent of total steam energy “lost” was calculated by comparing modeled heat losses to modeled steam injection;
- Since the actual steam injection rates at ST012 have been different than originally modeled, the percent heat loss calculated for each operational phase in the model was applied to the actual steam injected to get the calculated heat losses during operation; and,
- The calculated heat losses were subtracted from the net energy injection to calculate the net energy injected with heat losses.

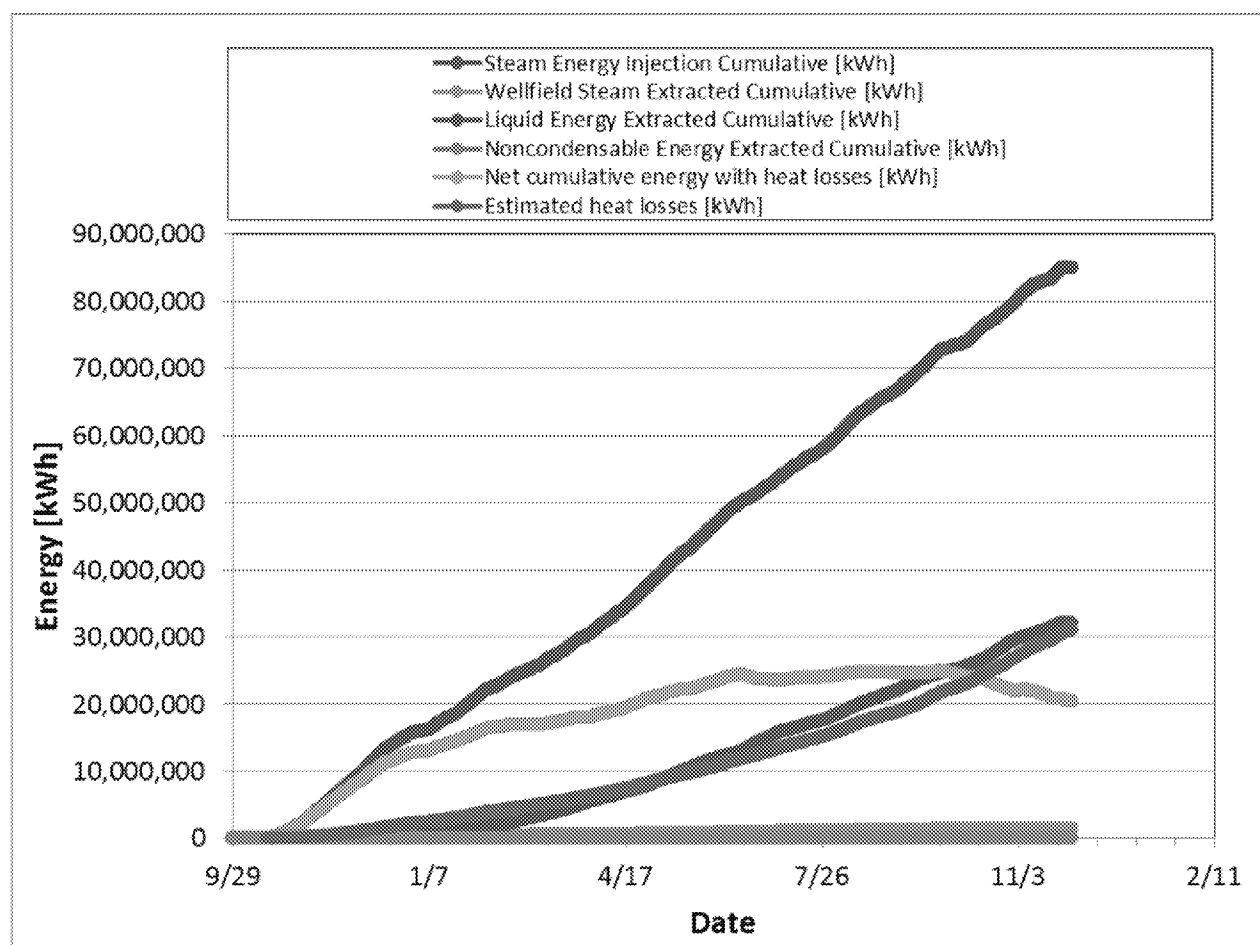


Figure 20. Cumulative Energy Balance

16. Energy Balance Rates

The energy balance rates are shown below.

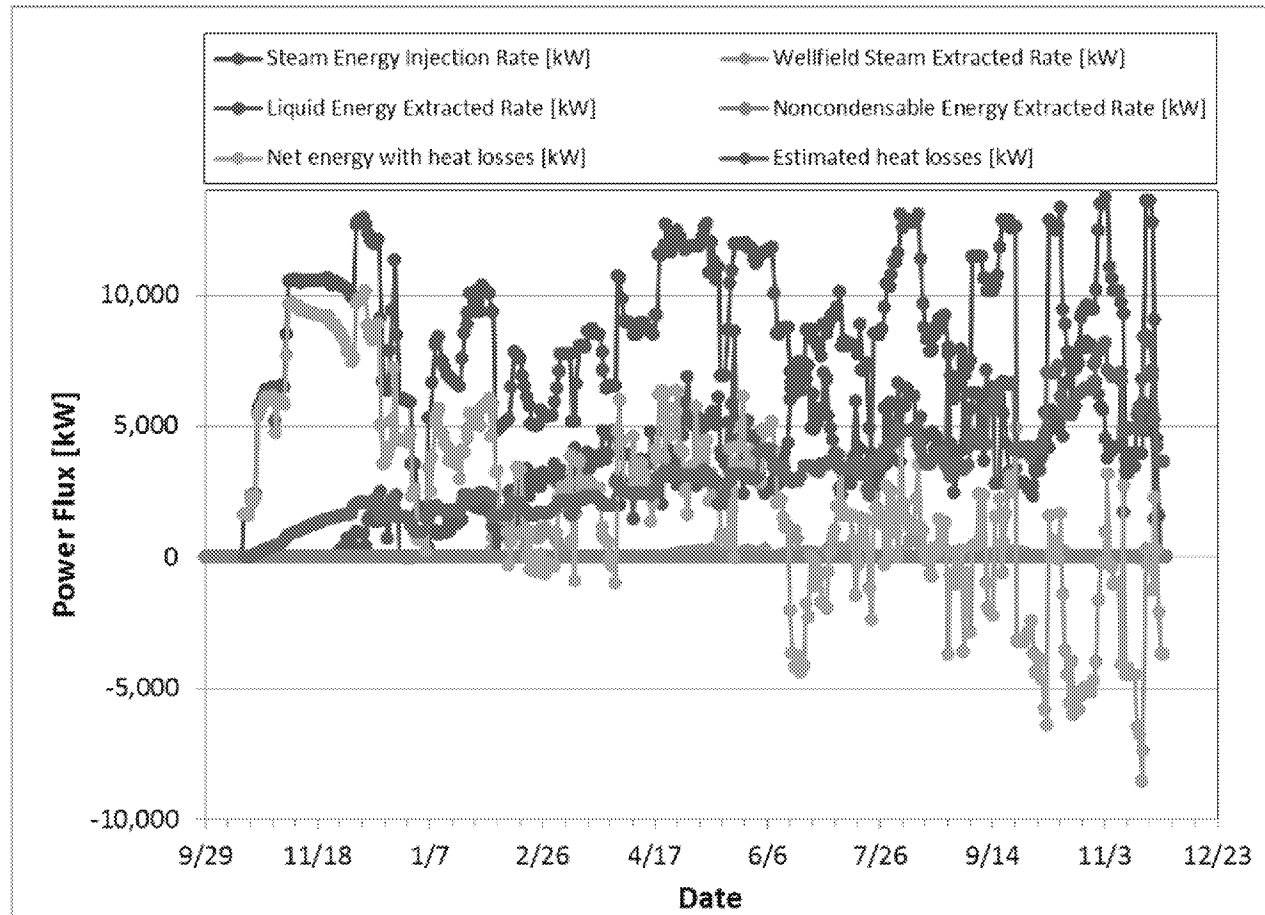


Figure 21. Energy Balance Rates

17. Perimeter Water Level Data

Table 4 below presents the change in perimeter groundwater elevations since SEE system startup. The readings collected on September 24, 2014 (not shown) represent baseline conditions. A negative number shows that the groundwater elevation is lower than the baseline elevation, thus indicating an inward hydraulic gradient into the treatment zone. Liquid extraction began on September 29, 2014. Perimeter water level data are collected on a weekly basis. The regional groundwater table at the Site is increasing at a rate of approximately 1.5 ft/year; thus, each measured value shown in Table 4 has been corrected to take the regional changes into account.

Table 4. Perimeter Groundwater Elevation Changes

Monitoring Well	11/6/2015		11/13/2015		11/20/2015		11/27/2015	
	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous
CZ/UWBZ Wells								
ST012-C01	-0.97	-0.11	-0.90	0.10	-1.06	-0.13	-1.08	0.01
ST012-C02	-0.82	-0.02	-0.67	0.18	-1.01	-0.32	-0.60	0.44
UWBZ Wells								
ST012-RB-3A	-0.33	1.82	-0.26	0.10	-0.88	-0.60	-1.15	-0.24
ST012-U02	-0.44	0.58	-0.30	0.17	-0.71	-0.39	-0.82	-0.08
ST012-U11	-0.36	0.94	-0.67	-0.28	-1.40	-0.71	-1.28	0.15
ST012-U12	-0.11	2.60	-0.63	-0.49	-1.75	-1.10	-2.12	-0.34
ST012-U37	0.03	3.74	-0.14	-0.14	-0.88	-0.72	-1.37	-0.46
ST012-U38	-0.80	0.80	-0.43	0.40	-0.79	-0.34	-0.80	0.02
LSZ Wells								
ST012-W11	-3.99	-2.20	-5.53	-1.52	-6.94	-1.38	-4.03	2.94
ST012-W12	-2.54	-0.92	-4.73	-2.16	-6.30	-1.55	-3.25	3.08
ST012-W24	-1.26	-0.07	-1.83	-0.54	-4.32	-2.47	-5.59	-1.24
ST012-W30	-2.20	-1.04	-4.20	-1.98	-6.14	-1.91	-2.97	3.20
ST012-W34	-1.31	-0.33	-3.67	-2.33	-5.08	-1.39	-2.46	2.65
ST012-W36	0.01	-0.01	-0.72	-0.70	-3.81	-3.07	-5.56	-1.72
ST012-W37	-1.71	0.46	2.79	4.52	-5.55	-8.31	0.80	6.38
ST012-W38	-1.17	-0.27	-3.14	-1.94	-4.51	-1.35	-2.07	2.47

Figure 22 shows the manually collected groundwater elevation trends since system startup. Additionally Figure 23 shows the groundwater elevations continuously logged in selected perimeter wells equipped with transducers. The regional groundwater table correction has also been applied to Figure 22 below.

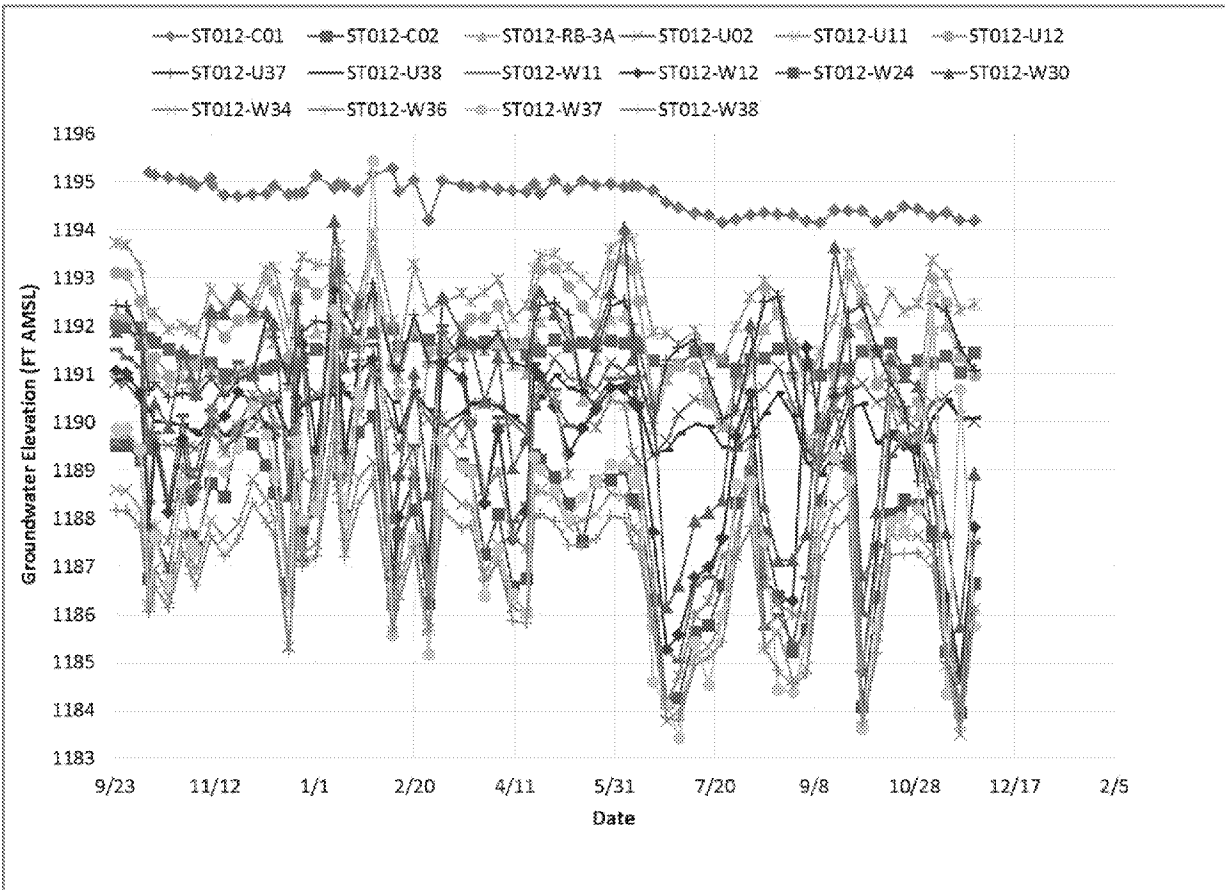


Figure 22. Manually Collected Perimeter Groundwater Elevations

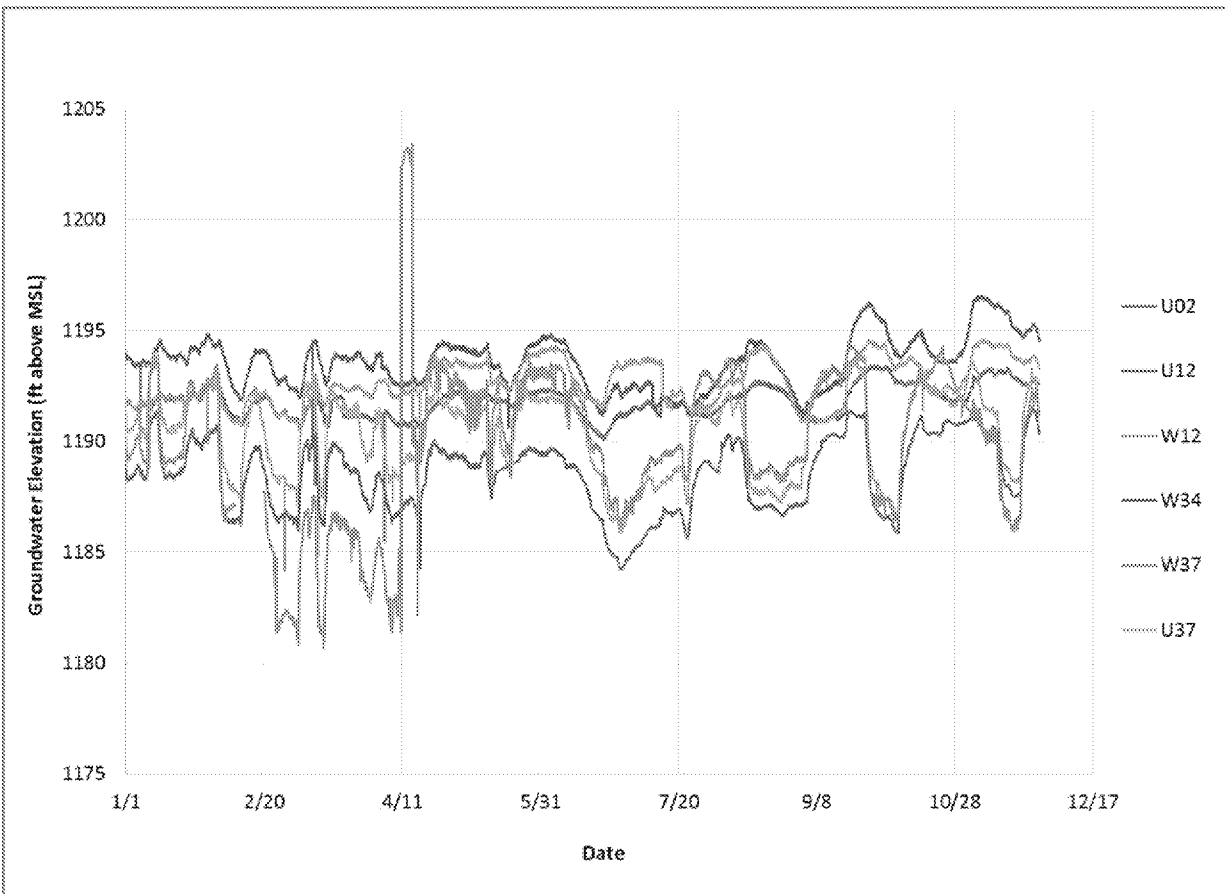


Figure 23. Automatically Collected Perimeter Groundwater Elevations

Table 5 below presents the measured LNAPL thicknesses of the perimeter wells at the site. Perimeter LNAPL thickness data are collected on a weekly basis.

Table 5. Perimeter LNAPL Thicknesses (ft)

Monitoring Well	11/6/2015		11/13/2015		11/14/2015		11/27/2015	
	Before bailing	After Bailing	Before bailing	After Bailing	Before bailing	After Bailing	Before bailing	After Bailing
CZ/UWBZ Wells								
ST012-C01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-C02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UWBZ Wells								
ST012-U02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-RB-3A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSZ Wells								
ST012-W11	45.71	10.04	21.63	14.49	23.33	20.19	2.77	2.77
ST012-W12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W30	0.13	0.13	0.00	0.00	0.03	0.03	0.03	0.03
ST012-W34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W37	4.39	0.20	82.36	17.94	3.15	0.22	13.59	13.59
ST012-W38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

On December 1, 2014, temperatures at selected perimeter wells were added to the monitoring program. Figure 24 below shows the manually collected temperatures recorded at the wells included in the monitoring program. Additionally Figure 25 shows the temperatures continuously logged in selected perimeter wells equipped with transducers.

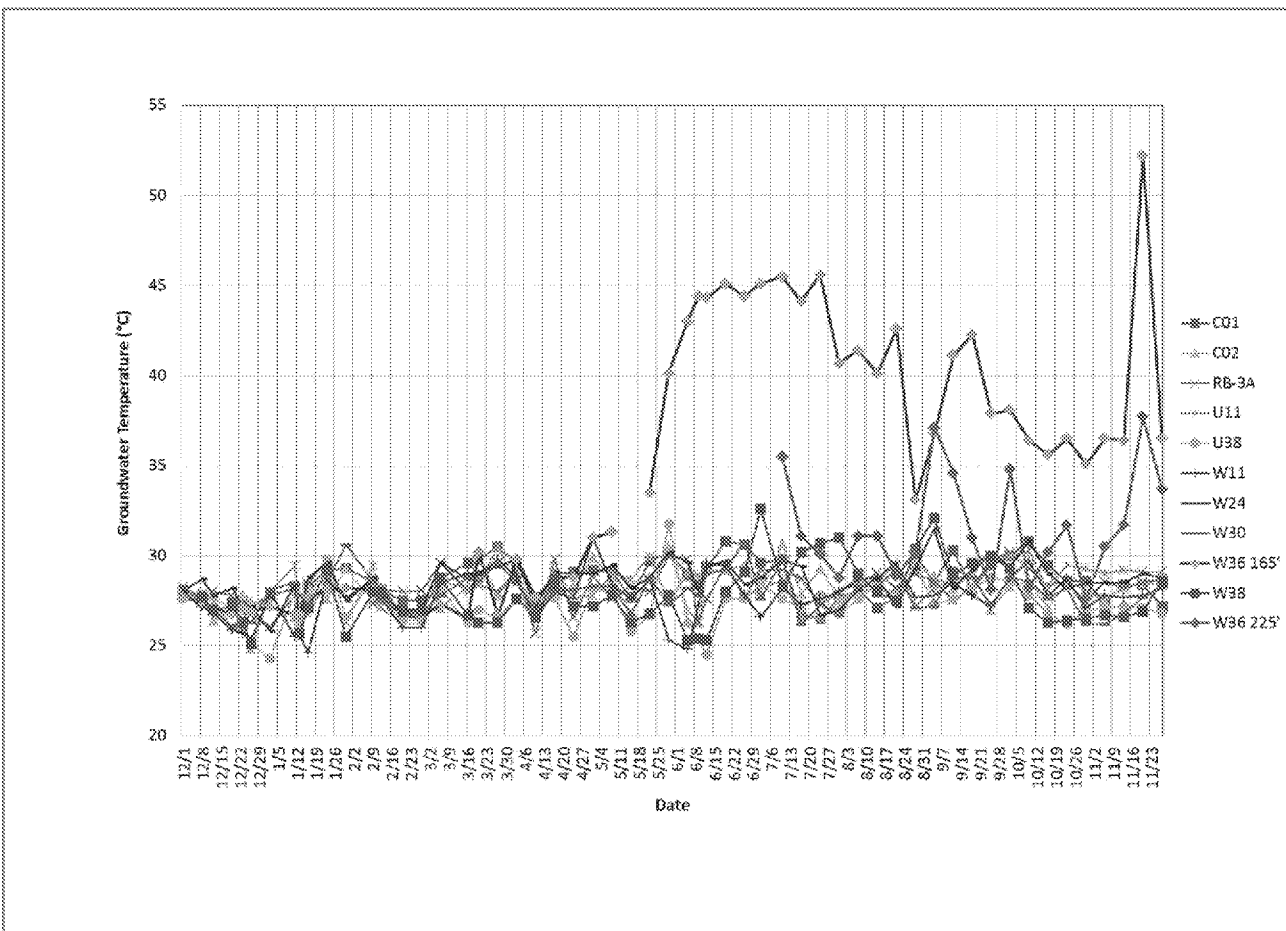


Figure 24. Manually Collected Perimeter Well Groundwater Temperatures

Note: Thermocouples are measured at approximate depths as follows (in feet below top of casing): C01=162; C02=168; RB-3A=161; U11=180; U38=164; W11=228; W24=230; W30=231; W36=225; and W38=228.

As a response to the increased temperatures observed at W36 on November 20, 2015 steam at nearby UWBZ9 and UWBZ25 were decreased.



Figure 25. Automatically Collected Perimeter Well Groundwater Temperatures

Notes:

On March 7, 2015 operational personnel replaced the U37 logger unit. The increase in temperature on March 7, 2015 at U37 is a result of this replacement.

Transducers are measured at depths as follows (in feet below top of casing): U02= 175; U12= 175; U37= 182; W12= 228; W34= 225; and W37= 226.

18. Natural Gas Usage

The following figure shows the natural gas usage rate in cubic feet per hour (cf/hr) and cumulative natural gas use in cubic feet (cf) to date at the site.

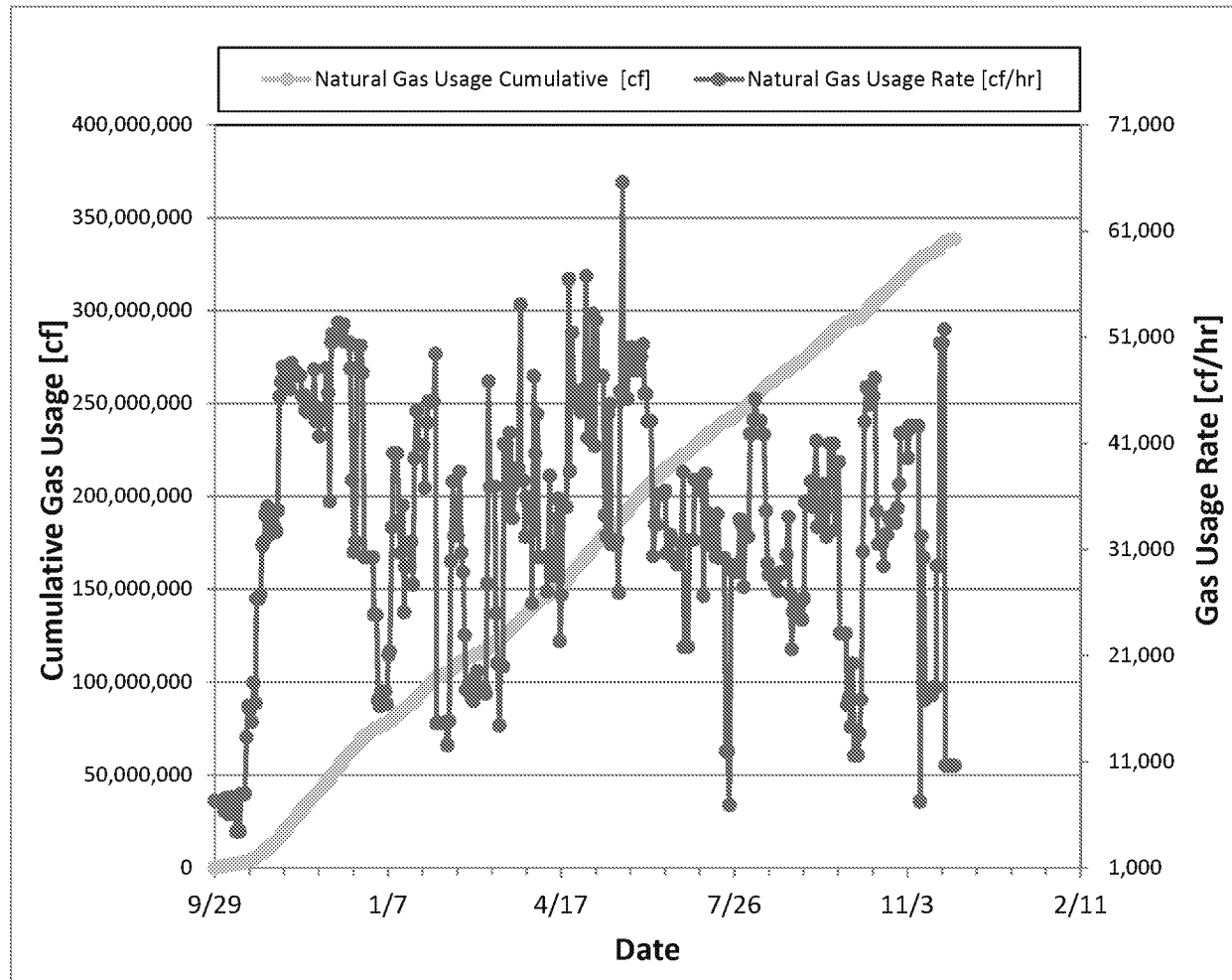


Figure 26. Natural Gas Usage

19. Waste Generation

On January 19, 2015 a total of 8,033 gallons of material from tank cleanout activities was removed from the site by Mesa Oil for recycling. The mass of JP-4 in the material was estimated to be 2,857 gallons or 18,800 lbs.

On February 18 and 19, 2015 a total of 24,430 gallons of material from tank cleanout activities was removed from the site by Mesa Oil for recycling. The mass of JP-4 in the material was estimated to be 3,645 gallons or 23,984 lbs.

On March 12, 2015 a total of 11,359 gallons of predominantly water from tank cleanout activities was removed from the site by Mesa Oil for recycling. The JP-4 mass in the water was limited.

On March 20, 2015 the first shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On March 30 and 31, 2015 a total of 32,000 lbs of spent liquid carbon was removed from the site by Evoqua Water Technologies for regeneration at their Red Bluff, CA facility.

On April 24, 2015 a shipment of bag filters (three cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On May 29, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On June 11, 2015 three 55-gallon drums of soil dug from around the Hypro NAPL filter were shipped offsite for non-hazardous disposal.

On June 10, 2015 a total of 5,727 gallons of oily bio-impacted water from tank cleanout activities was removed from the site by Mesa Oil for recycling.

On June 25, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On August 19, 2015 a total of 16,000 lbs of spent liquid carbon was removed from the site by Evoqua Water Technologies for regeneration at their Red Bluff, CA facility.

On August 27, 2015 a total of five totes with approximately 250 gallons each of water/solids from disinfection of the liquid carbon vessel were removed from the site by MP Environmental for disposal.

On October 22, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On November 23, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

20. NAPL Reuse

On April 7, 2015 a total of 12,647 gallons of stored NAPL was sent to Mesa Oil for reuse. The analysis showed that 703 gallons of the total fluid was water. The water has been subtracted from the NAPL recovery estimate.

On April 21-22, 2015 a total of 13,076 gallons of stored NAPL was sent to Mesa Oil for reuse. Analysis showed a water content between <1% to 3% or a total of 227 gallons of water. The water removed has been subtracted from the NAPL recovery estimate.

On May 7, 2015 a total of 5,722 gallons of stored NAPL was sent to Mesa Oil for reuse.

On May 21, 2015 a total of 1,400 gallons of stored NAPL was sent to Mesa Oil for reuse.

On June 24, 2015 a total of 6,771 gallons of stored NAPL was sent to Mesa Oil for reuse.

21. Estimated Formation Water Temperature

The estimated formation water temperatures are indicated in Table 6 below. The formation water temperatures have been estimated for each MPE well by measuring the eductor liquid feed and return flow rate together with the eductor liquid feed and return temperatures. The enthalpy increase in the liquid return temperature as compared to the liquid feed stream temperature is used to provide the MPE well specific formation temperature. Estimated formation water temperatures above the boiling point likely indicate that steam is being pulled into the liquid extraction system. These estimated data for each MPE well location are used in conjunction with the extracted vapor data collected at the MPE wells to make determinations on steam breakthrough around the site. All of these data are reviewed holistically (with other site data such as the TMP data) to determine when and where steam cycling events should commence.

The location of each MPE well is also indicated in the table. Since perimeter extraction wells are expected to extract colder water from outside of the treatment zone, the formation temperature at these locations is not expected to reach steam temperatures. Thus, full or partial steam breakthrough can still be occurring at the perimeter locations without the estimated formation water temperature being at boiling. Please note that if the estimated formation water temperature is higher than 220°C for a given well, ">220" is indicated in the table.

Please note that no vapor temperature data were collected from the MPE wellheads November 5-13, 2015 due to issues with the temperature equipment.

Table 6. Estimated Well Formation Temperatures

Formation Temperatures																											
Well	Well	Required to Reach	Reached Steam	Vapor Extraction	9/1/15	9/3/15	9/7/15	9/9/15	9/11/15	9/15/15	9/17/15	9/21/15	9/23/15	9/29/15	10/1/15	10/6/15	10/8/15	10/13/15	10/15/15	10/20/15	10/22/15	10/27/15	10/29/15	11/3/15	11/5/15	11/17/15	11/23/15
	Location	Steam Temperature	Temperature (Calculated)	Max Temperature [°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]
CZ07	Perimeter	No	No	131	149	163		159		152		137		167	155	126	191		166	191	210	>220	211	215	138	205	93
CZ08	Perimeter	No	No	138		173		195		199		189		91	147	153	156		173		175	174	183	186	136	202	194
CZ09	Perimeter	No	No	105	130	109	132	98	139	104	103	96	138	139	159	120	124	138	144	109	120	111	112	131	100		139
CZ10	Perimeter	No	Yes	206		195		213		174		175		133	151	114	>220			65	120	123		88	111	181	197
CZ11	Interior	Yes	Yes	212														212	>220	>220	>220	>220	>220	>220	159	>220	>220
CZ12	Perimeter	No	Yes	105	151	143	117	140	156	116	162	157	150	141	144	130		121			162	162	173	181	143		201
CZ13	Perimeter	No	Yes	160		160		167		168		>220		138	122	145	135			166	168	169	175	177	178	211	178
CZ14	Perimeter	No	Yes	112	191	136	185	>220	>220	211	198	>220	>220	>220	>220	>220	212	>220	>220	>220	>220	>220	>220	>220	197		>220
CZ15	Interior	Yes	Yes	120	>220	133	200	>220	192		195	>220	195	98	122	121	157	113	105	200	207	>220	182	>220	168	201	210
CZ16	Perimeter	No	Yes	205	>220	>220	>220	>220	>220	198	>220	96	>220	132	158	132	176	>220	>220	>220	>220	>220	>220	>220	203		>220
CZ17	Perimeter	No	Yes	200		175	131	140	155	156	>220	181	136	133	148	134	144	167	186	210	210	164	189	>220	>220	176	>220
CZ18	Perimeter	No	No	100		108	119		134	104	126		126		126	105	122	134	103	160	133	150	158	174	160	174	105
CZ19	Perimeter	No	No	110		150	139	148	128		148	115	145	134	135	135	141	152	107	181	171	169	205	178	182	181	206
CZ20	Outside CZ	No	No	111	96	91	95		101	83	92		99		97	91	100	96	98	96	95	93	90	81	91	87	88
LSZ01	Interior	Yes	Yes	126	130	184	157	183	182	113	132	174	194	194	193	186	201	189	182	193	196	>220	199	204	131		219
LSZ02	Interior	Yes	Yes	130	166	189	74				>220	>220	>220	>220	191	29		213	>220	89				>220	176	>220	>220
LZS04	Interior	Yes	Yes	206											93												
LSZ05	Interior	Yes	Yes	220	75	80	213	>220	>220	>220	76	85	>220														
LSZ06	Interior	Yes	Yes	218	>220	187	191	217	216	>220	>220	96	>220	>220	>220	>220	>220	>220	204	>220	>220	>220	>220	>220	196		>220
LSZ08	Perimeter	No	Yes	120	209	205		202		107		>220		144	212	>220	208		179	>220	>220	>220	>220	>220	>220	>220	>220
LSZ11	Perimeter	No	Yes	119	99	0	>220	>220			0	104					144	121	137	129	119	123	121	124		164	215
LSZ12	Perimeter	No	No	126	159	172	174	175	165	171	183	168	192	192	170	168	170	175	190	186	186	187	188	188	130	193	189
LSZ13	Interior	Yes	Yes	125		189	190	201	158	179	198	220	199	205	218	196	206	218	>220	209	216	210	215	186	122	195	>220
LSZ14	Perimeter	No	No	125	161	165	172	180	186	185	185	190	196	185	169	164	162	172	183	191	183	194	202	218	135	202	198
LSZ15	Interior	Yes	Yes	208	195	>220	>220		>220	>220	>220		>220		212	205	196	220	>220	219	>220						>220
LSZ16	Interior	Yes	Yes	205	157	158	182	186	191		176	107	200	160	160	152	160	170	208	193	181	187	190	183	126	186	182
LSZ17	Perimeter	No	Yes	220		140		165		98		172		120	119	109	109			129	127	119	116	115	112	115	110
LSZ28	Perimeter	No	Yes	129		164		178		177		185		0	167	150	156		174	185	184	187	190	194	100		173
LSZ29	Perimeter	No	No	116		166	155	167	169	59	195	179	190	187	184	176	189	198	185	171	186	191	206	>220	141	>220	>220
LSZ30	Interior	Yes	Yes	133	212	201	211		217	215	215		214		>220	198	203	218	>220	>220	>220	131	>220	>220	>220	>220	>220
LSZ31	Interior	Yes	Yes	147		97	173	186	187	176	188	202	208	191	175	184	>220	>220	>220	>220	>220		189	>220	150		>220
LSZ32	Interior	Yes	Yes	120		187	175	197	195	208	163	206	195	215	202	178	192	211	213	214	>220	217	>220	>220	150	>220	>220
LSZ33	Perimeter	No	Yes	130	179	184	179	185	182	105	192	166	198	192	192	188	183	186	192	195	193	197	201	208	144	>220	>220
LSZ34	Interior	Yes	Yes	168		113	162	192	127	121	124	192	207	120	171	203	187	142	132	146	197	202	215	206	142	>220	>220
LSZ35	Perimeter	No	Yes	121	202	119	114	119	130	117	116	107	133	124	127	124	124	125	124	120	127	131	126	136	126	126	134
LSZ36	Perimeter	No	Yes	128	177	177	178	180	171	119	193	213	207	193	192	171	171	181	189	>220	177	152		>220	189	>220	>220
LSZ37	Perimeter	No	Yes	208	91	144	172		200	194	200		216		176	116	113	208	>220	220	212	127	215	>220	>220	140	200
LSZ38	Perimeter	No	Yes	116	153	163	153		150	134	175		165		161	141	176	166	128	178	195	113	>220	98		147	151
LSZ39	Perimeter	No	No	118		112	109		126	116	117		135		135	109	113	119	144	130	131	105	132	148	143	135	
LSZ40	Interior	Yes	Yes	135	200	198	208	210	216	>220	209	>220	>220	>220	>220	210	193	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220
LSZ42	Perimeter	No	Yes	130	181	188	101	193	183	102	184	166	190	194	180	184	189	187	190	193	195	200	202	201	139	>220	>220

Formation Temperatures																											
Well	Well	Required to Reach	Reached Steam	Vapor Extraction	9/1/15	9/3/15	9/7/15	9/9/15	9/11/15	9/15/15	9/17/15	9/21/15	9/23/15	9/29/15	10/1/15	10/6/15	10/8/15	10/13/15	10/15/15	10/20/15	10/22/15	10/27/15	10/29/15	11/3/15	11/5/15	11/17/15	11/23/15
	Location	Steam Temperature	Temperature (Calculated)	Max Temperature [°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]
UWBZ01	Interior	Yes	Yes	150	0	97		>220	>220	>220	77	>220	68	>220	>220	>220	>220	140	>220	177	172	>220	205	201	143		>220
UWBZ02	Interior	Yes	Yes	208	>220	>220	>220	>220	>220	>220	165	>220	>220	>220	190	>220	>220	>220	>220	>220	>220	>220	197	84			
UWBZ04	Interior	Yes	Yes	188		143		146		145		>220		>220							205	217	39	>220	182	>220	>220
UWBZ05	Interior	Yes	Yes	220							196	>220	>220	>220	>220	>220	>220	>220	>220	>220	214	200	196	>220	165	>220	>220
UWBZ06	Interior	Yes	Yes	165	159	174	159	154	167	155	170	166	173	141	185	189	203	94	96	97	95	93	207	>220	135	0	170
UWBZ10	Perimeter	No	Yes	179		172		170		>220				204	209	217	>220		>220	188	180	187	182	199	144	>220	>220
UWBZ17	Perimeter	No	Yes	220		>220		>220		178		>220		162	>220	148	>220		>220	185	188	170	183	206	140	>220	>220
UWBZ18	Interior	Yes	Yes	180	100	>220	182	>220	>220	>220	>220	104	156	>220	180	>220	>220	>220	162	>220	>220	>220	150	>220	102	195	>220
UWBZ19	Perimeter	No	Yes	162	>220	>220	>220	>220	>220	198	154	137	208	207	198	133	>220	>220	>220	209	198	94	182	187	132		>220
UWBZ20	Dual Phase - Perimeter	No	No	112															108								187
UWBZ21	Outside UWBZ	No	No	118		108	149	154	141	141	129	166	171	172	165	162	156	166	148	165	175	173	173	166	112	217	>220
UWBZ22	Perimeter	No	No	127		121	120	136	130	115	100	121	140	136	143	155	170	158	164	82	131	133	134	118	127	207	>220
UWBZ23	Outside UWBZ	No	Yes	131		213	197	203	211	62	>220	214	219	215	171	214	215	>220	>220	>220	218	208	213	212	146	>220	>220
UWBZ24	Dual Phase - Perimeter	No	No	190	133	153	107	158	109		154	110	125	150	111	140	139	155		106	95	94		95	30	>220	
UWBZ26	Outside UWBZ	No	No	105	113	112	81		137	122	122		128		123	116	131	123	134	116	133	100	116	130	112	131	130
UWBZ27	Outside UWBZ	No	Yes	115	>220	>220	90		>220	89	201		>220		165	210	191	>220	>220	>220	>220	105	>220	>220	216	215	

RED	: at or above steam temperature (≥210 °F)
GREEN	: below steam temperature (<210 °F)

22. NAPL Screening Results and Calculated Benzene Concentrations

Figures 27-29 below present the screening level results for NAPL detected in samples collected from MPE wells across the site. Screening samples are typically collected on a weekly basis. The figures below also include calculated benzene concentrations of groundwater samples collected from MPE wells across the site.

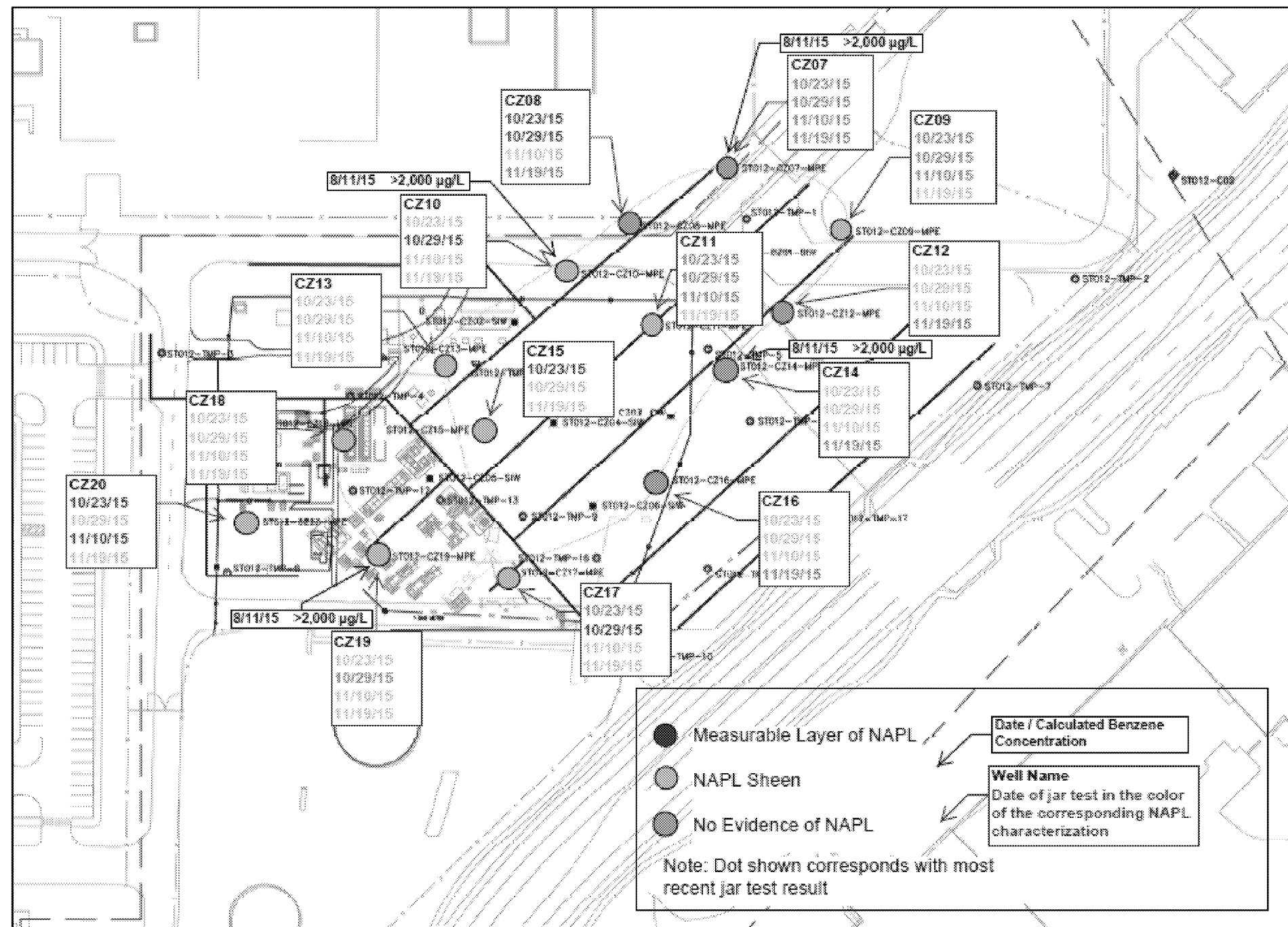


Figure 27. NAPL Screening Results and Calculated Benzene Concentrations – Cobble Zone

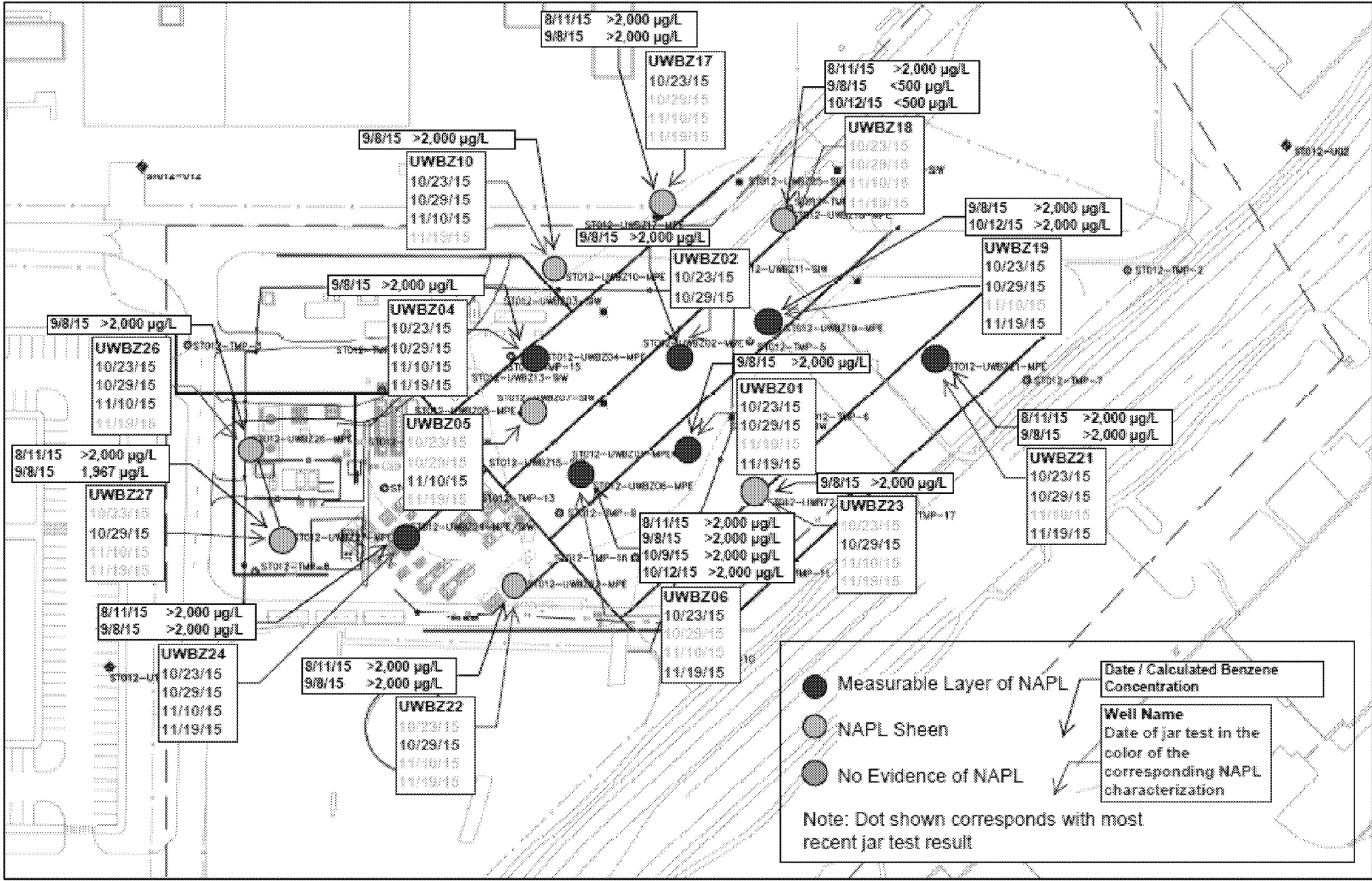


Figure 28. NAPL Screening Results and Calculated Benzene Concentrations – Upper Water Bearing Zone

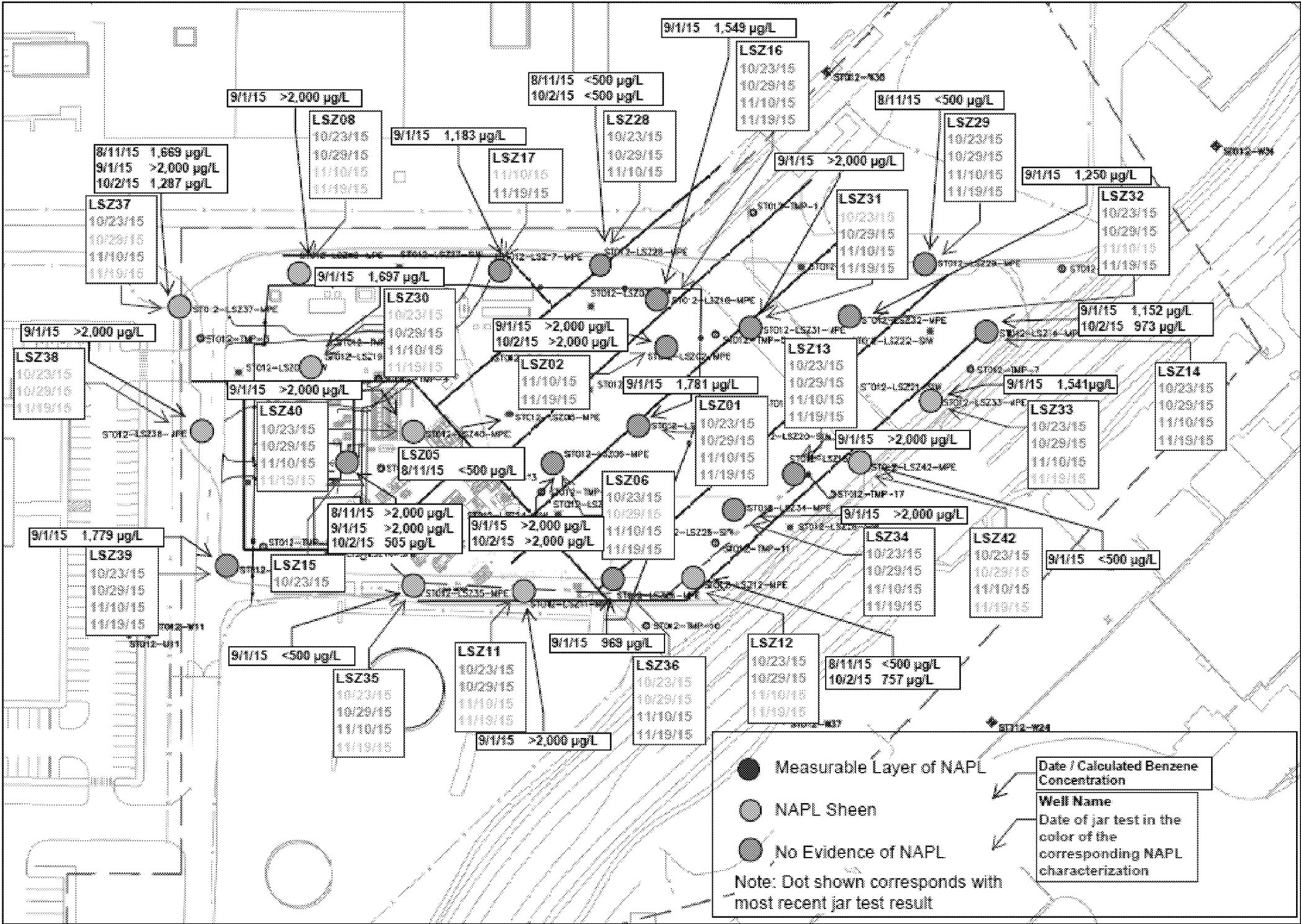


Figure 29. NAPL Screening Results and Calculated Benzene Concentrations – Lower Saturated Zone